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(12) **United States Patent**
Minami

(10) **Patent No.: US 9,132,662 B1**
(45) **Date of Patent: Sep. 15, 2015**

(54) **PRINTING DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Dec. 31, 2014**

(30) **Foreign Application Priority Data**

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Apr. 14, 2014 (JP) 2014-082886

(51) **Int. Cl.**
B41J 2/355 (2006.01)
B41J 2/335 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/335*** (2013.01); ***B41J 2/355*** (2013.01); *B41J 2/3551* (2013.01); *B41J 2/3556* (2013.01)

(58) **Field of Classification Search**
USPC 347/211, 180, 181, 182, 186
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,412,406 A * 5/1995 Fujimoto 347/180
7,582,849 B2 9/2009 Watanabe et al.
8,384,750 B2 * 2/2013 Matsutani 347/211
8,654,160 B2 * 2/2014 Kano 347/188
8,670,010 B2 3/2014 Kano
8,803,932 B2 * 8/2014 Matsutani 347/211
2007/0045280 A1 3/2007 Watanabe et al.
2011/0242256 A1 * 10/2011 Matsutani 347/211
2012/0092433 A1 4/2012 Ogura et al.
2013/0194371 A1 8/2013 Kano

FOREIGN PATENT DOCUMENTS

JP S61-264959 A 11/1986
JP S63-224964 A 9/1988
JP H05-016415 A 1/1993
JP 2007-062282 A 3/2007
JP 2011-025641 A 2/2011
JP 2012-081698 A 4/2012
JP 2012-232600 A 11/2012
JP 2013-022925 A 2/2013
WO 2012-132987 A1 10/2012

* cited by examiner

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(57) **ABSTRACT**

Every print line lined up to the number of "preset line number 1", the dot number that the main pulse MP is added is counted, and when the variable number M which is the most count number is larger than the variable number A, the value of variable number M/variable number A is set to the variable number of "divisional number" and "9" is set to the variable number of "target speed". When the variable number M corresponding to the most count number is not larger than the variable number A, the dot number that the supplemental pulse HP is added is counted every print line lined up to the number of "preset line number 1" and when the variable number S corresponding to the most count number is larger than the variable number A, "0" is set to the variable number of "divisional number" and "24" is set to the variable number of "target speed".

4 Claims, 21 Drawing Sheets

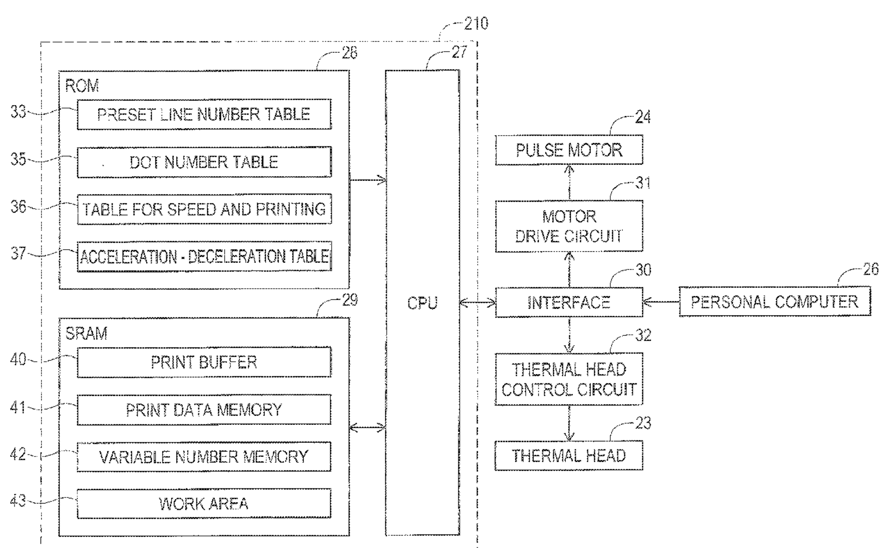


FIG. 1

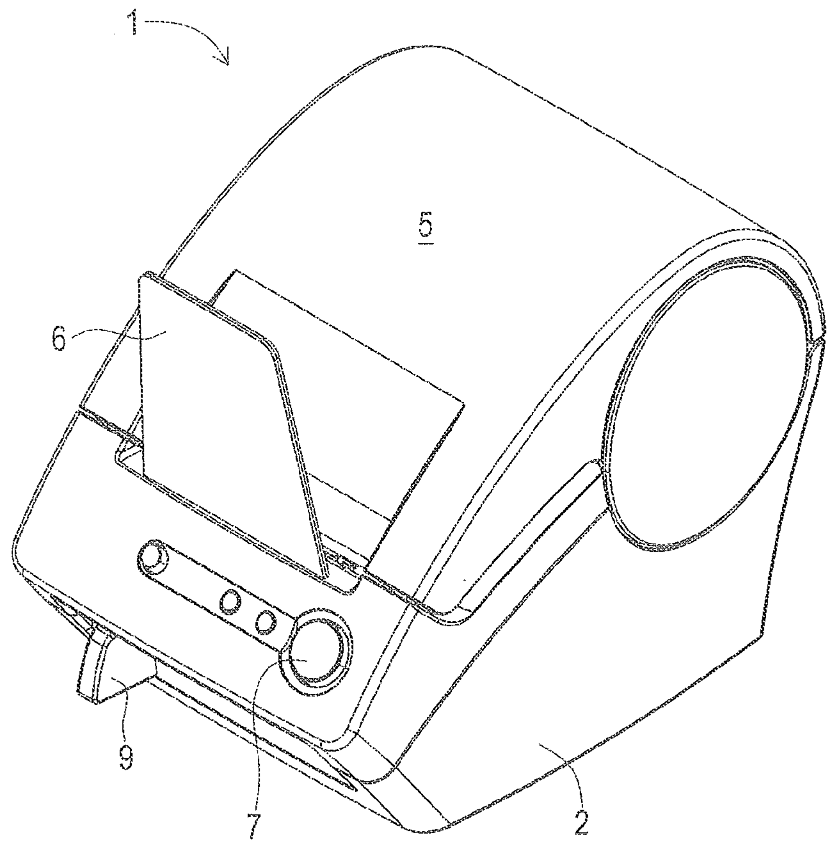
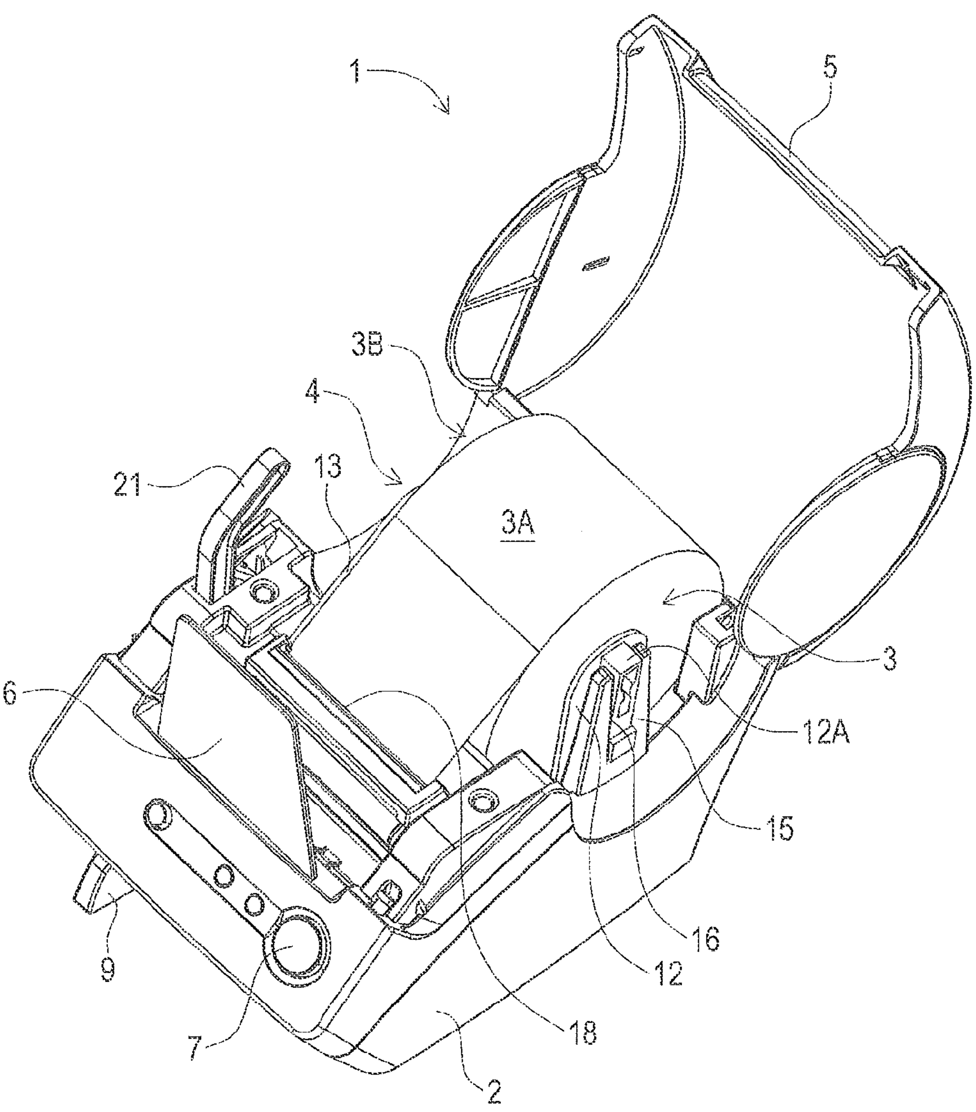


FIG. 2



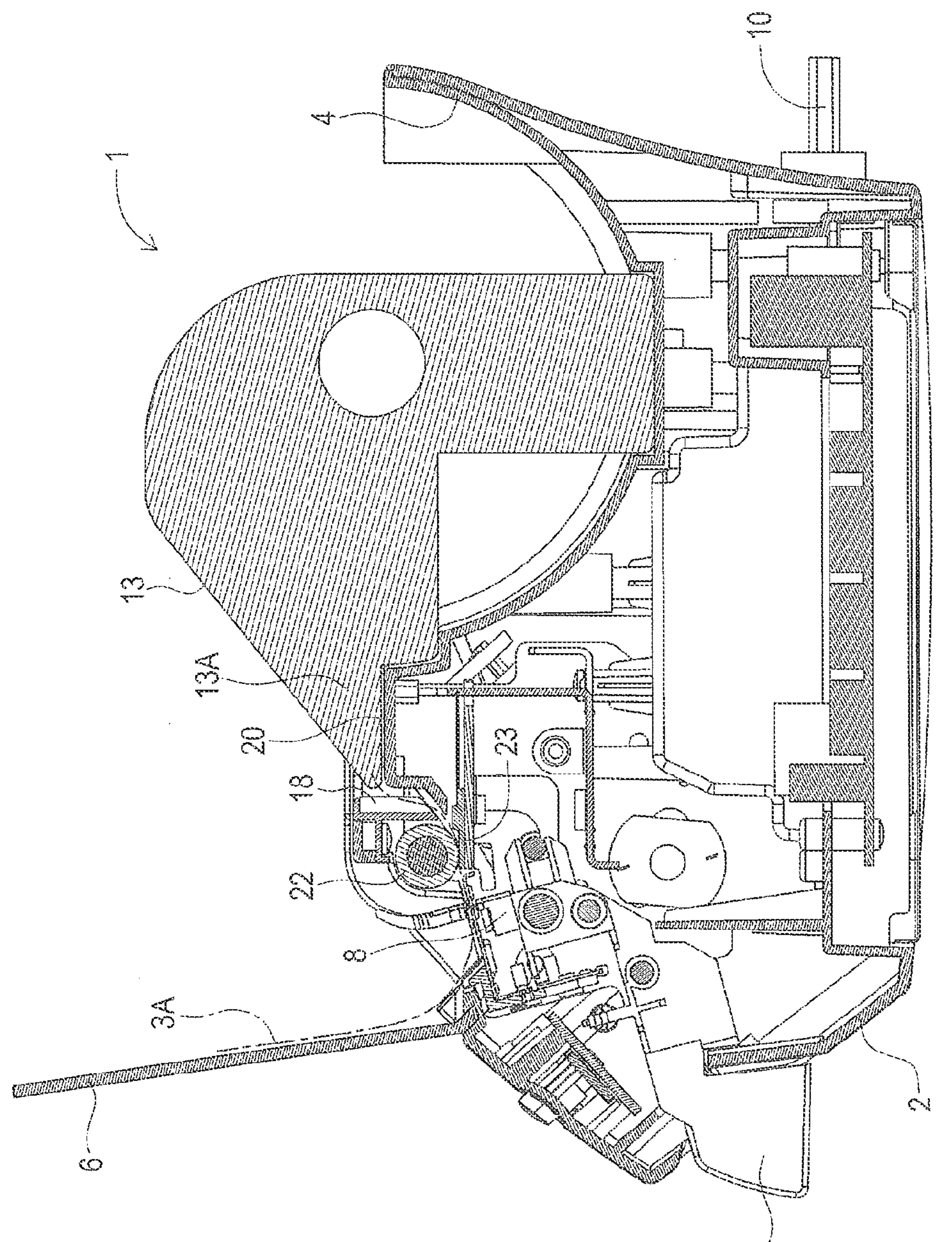


FIG. 3

FIG. 4

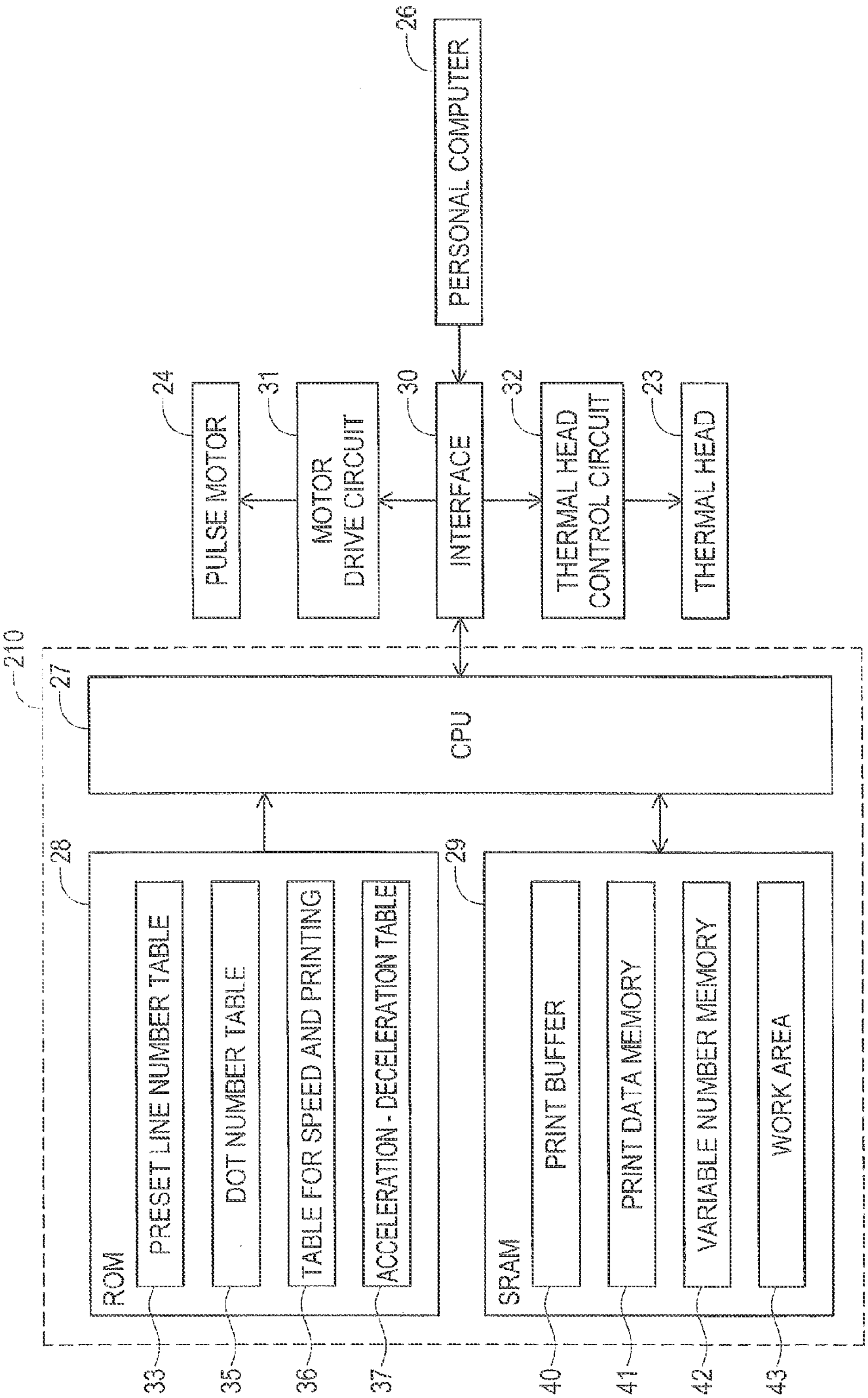

PERSONAL COMPUTER
26
PULSE MOTOR
24
MOTOR DRIVE CIRCUIT
31
INTERFACE
30
THERMAL HEAD CONTROL CIRCUIT
32
THERMAL HEAD
23
210
CPU
27
ROM
28
PRESET LINE NUMBER TABLE
33
DOT NUMBER TABLE
35
TABLE FOR SPEED AND PRINTING
36
ACCELERATION - DECELERATION TABLE
37
SRAM
29
PRINT BUFFER
40
PRINT DATA MEMORY
41
VARIABLE NUMBER MEMORY
42
WORK AREA
43

FIG. 5

PRESET LINE NUMBER TABLE

NAME	NUMBER
PRESET LINE NUMBER 1	20
PRESET LINE NUMBER 2	10

FIG. 6

DOT NUMBER TABLE

NAME	NUMBER
MAXIMUM ON-DOT NUMBER	180
TOTAL DOT NUMBER OF HEAD	360

FIG. 7

TABLE FOR SPEED AND PRINTING

NUMBER	SPEED mm/s	PRINT PULSE	DIVISIONAL PRINTING
0	0	MAIN PULSE + SUPPLEMENTAL PULSE	○
1	2	MAIN PULSE + SUPPLEMENTAL PULSE	○
2	4	MAIN PULSE + SUPPLEMENTAL PULSE	○
3	6	MAIN PULSE + SUPPLEMENTAL PULSE	○
4	9	MAIN PULSE + SUPPLEMENTAL PULSE	○
5	11	MAIN PULSE + SUPPLEMENTAL PULSE	○
6	14	MAIN PULSE + SUPPLEMENTAL PULSE	○
7	17	MAIN PULSE + SUPPLEMENTAL PULSE	○
8	27	MAIN PULSE + SUPPLEMENTAL PULSE	○
9	30	MAIN PULSE + SUPPLEMENTAL PULSE	○
10	34	MAIN PULSE + SUPPLEMENTAL PULSE	-
11	43	MAIN PULSE + SUPPLEMENTAL PULSE	-
12	50	MAIN PULSE + SUPPLEMENTAL PULSE	-
13	56	MAIN PULSE + SUPPLEMENTAL PULSE	-
14	62	MAIN PULSE + SUPPLEMENTAL PULSE	-
15	66	MAIN PULSE + SUPPLEMENTAL PULSE	-
16	72	MAIN PULSE + SUPPLEMENTAL PULSE	-
17	76	MAIN PULSE + SUPPLEMENTAL PULSE	-
18	81	MAIN PULSE + SUPPLEMENTAL PULSE	-
19	87	MAIN PULSE + SUPPLEMENTAL PULSE	-
20	93	MAIN PULSE + SUPPLEMENTAL PULSE	-
21	98	MAIN PULSE + SUPPLEMENTAL PULSE	-
22	102	MAIN PULSE + SUPPLEMENTAL PULSE	-
23	106	MAIN PULSE + SUPPLEMENTAL PULSE	-
24	110	MAIN PULSE + SUPPLEMENTAL PULSE	-
25	114	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-

FIG. 8

ACCELERATION-DECELERATION TABLE

PRINT SPEED		PRESENT SPEED																									
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
TARGET SPEED	0	0	0	0	0	0	0	0	0	0	0	0	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	1	1	1	1	1	1	1	1	1	1	1	1	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	2	2	2	2	2	2	2	2	2	2	2	2	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	3	3	3	3	3	3	3	3	3	3	3	3	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	4	4	4	4	4	4	4	4	4	4	4	4	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	5	5	5	5	5	5	5	5	5	5	5	5	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	6	6	6	6	6	6	6	6	6	6	6	6	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	7	7	7	7	7	7	7	7	7	7	7	7	7	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	9	9	9	9	9	9	9	9	9	9	9	9	9	9	10	11	12	14	15	16	17	18	19	20	21	22	23
	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	12	14	15	16	17	18	19	20	21	22	23
	11	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11	12	14	15	16	17	18	19	20	21	22	23
	12	10	10	10	10	10	10	10	10	10	12	12	12	12	12	12	12	14	15	16	17	18	19	20	21	22	23
	13	10	10	10	10	10	10	10	10	10	12	13	13	13	13	13	13	14	15	16	17	18	19	20	21	22	23
	14	10	10	10	10	10	10	10	10	10	12	13	14	14	14	14	14	14	15	16	17	18	19	20	21	22	23
	15	10	10	10	10	10	10	10	10	10	12	13	14	15	15	15	15	15	15	16	17	18	19	20	21	22	23
	16	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	16	16	16	16	17	18	19	20	21	22	23
	17	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	17	17	17	17	18	19	20	21	22	23
	18	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	18	18	18	19	20	21	22	23
	19	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	19	19	19	20	21	22	23
	20	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	20	20	20	21	22	23
	21	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	21	21	21	22	23
	22	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	22	22	22	22	23
	23	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	22	23	23	23	23
	24	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	22	23	24	24	24
	25	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	22	23	24	25	25

FIG. 9

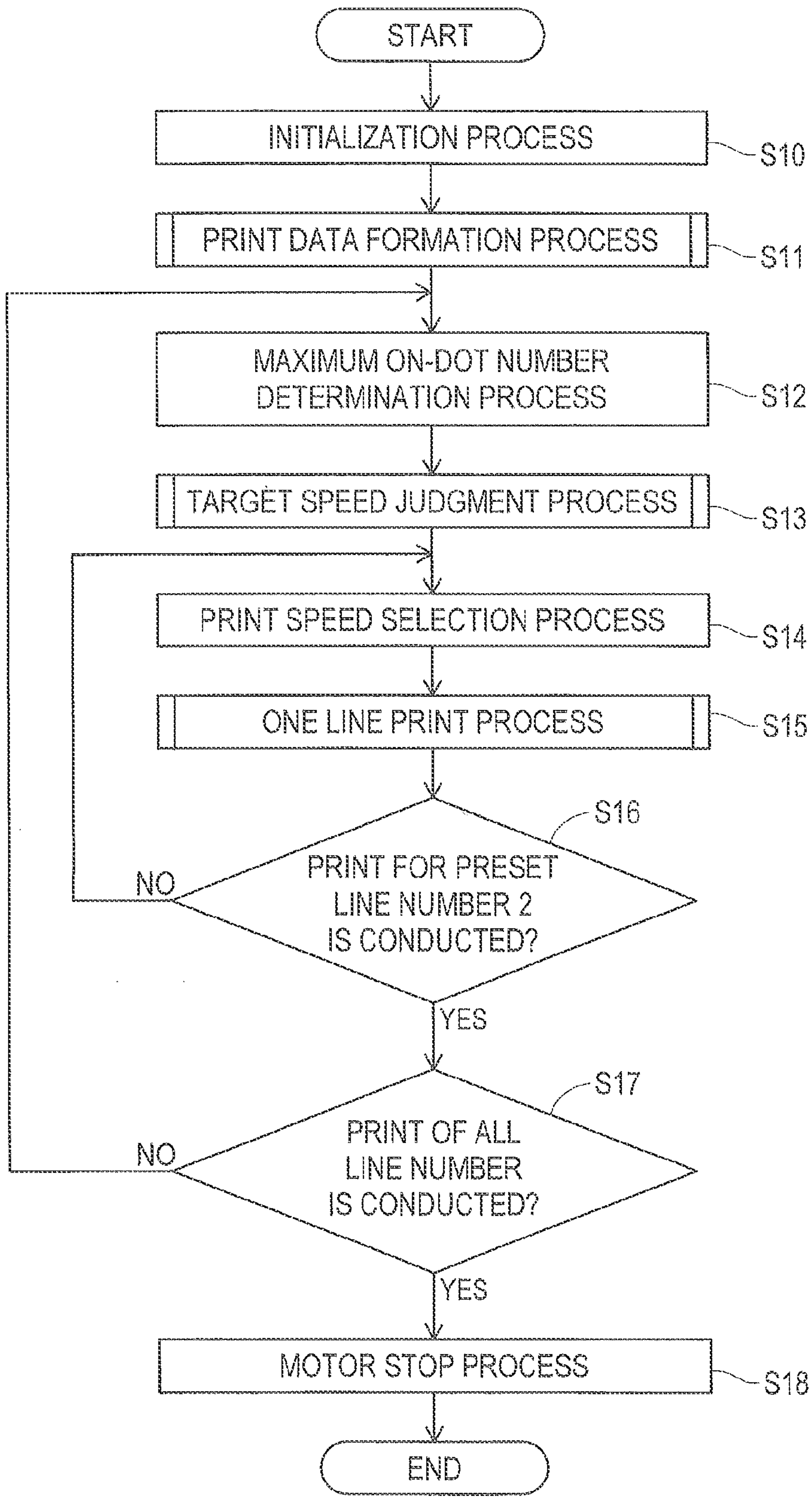

START
INITIALIZATION PROCESS
S10
PRINT DATA FORMATION PROCESS
S11
MAXIMUM ON-DOT NUMBER DETERMINATION PROCESS
S12
TARGET SPEED JUDGMENT PROCESS
S13
PRINT SPEED SELECTION PROCESS
S14
ONE LINE PRINT PROCESS
S15
S16
PRINT FOR PRESET LINE NUMBER 2 IS CONDUCTED?
NO
YES
S17
PRINT OF ALL LINE NUMBER IS CONDUCTED?
NO
YES
MOTOR STOP PROCESS
S18
END

FIG. 10

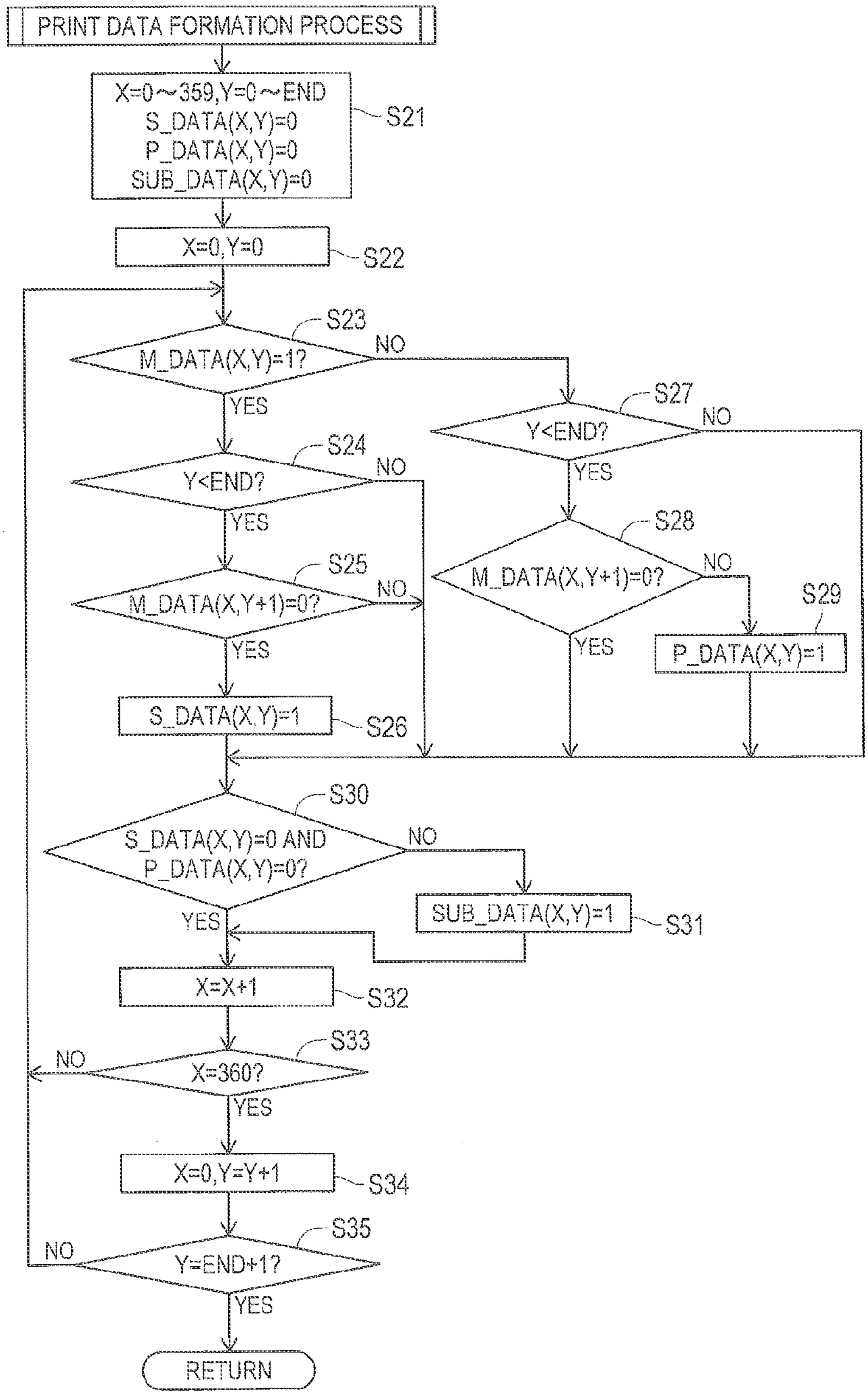

PRINT DATA FORMATION PROCESS
X=0～359,Y=0～END
S_DATA(X,Y)=0
P_DATA(X,Y)=0
SUB_DATA(X,Y)=0
S21
X=0,Y=0
S22
S23
M_DATA(X,Y)=1?
NO
YES
S27
Y<END?
NO
YES
S24
Y<END?
NO
YES
S28
M_DATA(X,Y+1)=0?
NO
YES
S25
M_DATA(X,Y+1)=0?
NO
YES
S29
P_DATA(X,Y)=1
S_DATA(X,Y)=1
S26
S30
S_DATA(X,Y)=0 AND
P_DATA(X,Y)=0?
NO
YES
SUB_DATA(X,Y)=1
S31
X=X+1
S32
S33
X=360?
NO
YES
X=0,Y=Y+1
S34
S35
Y=END+1?
NO
YES
RETURN

FIG. 11

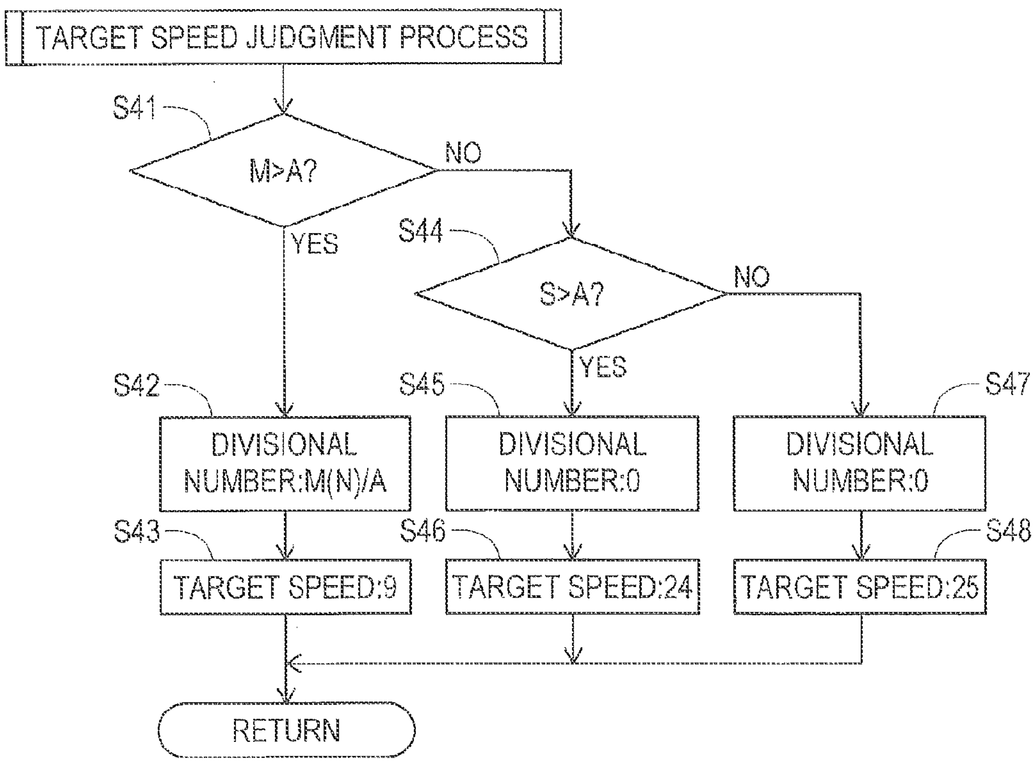
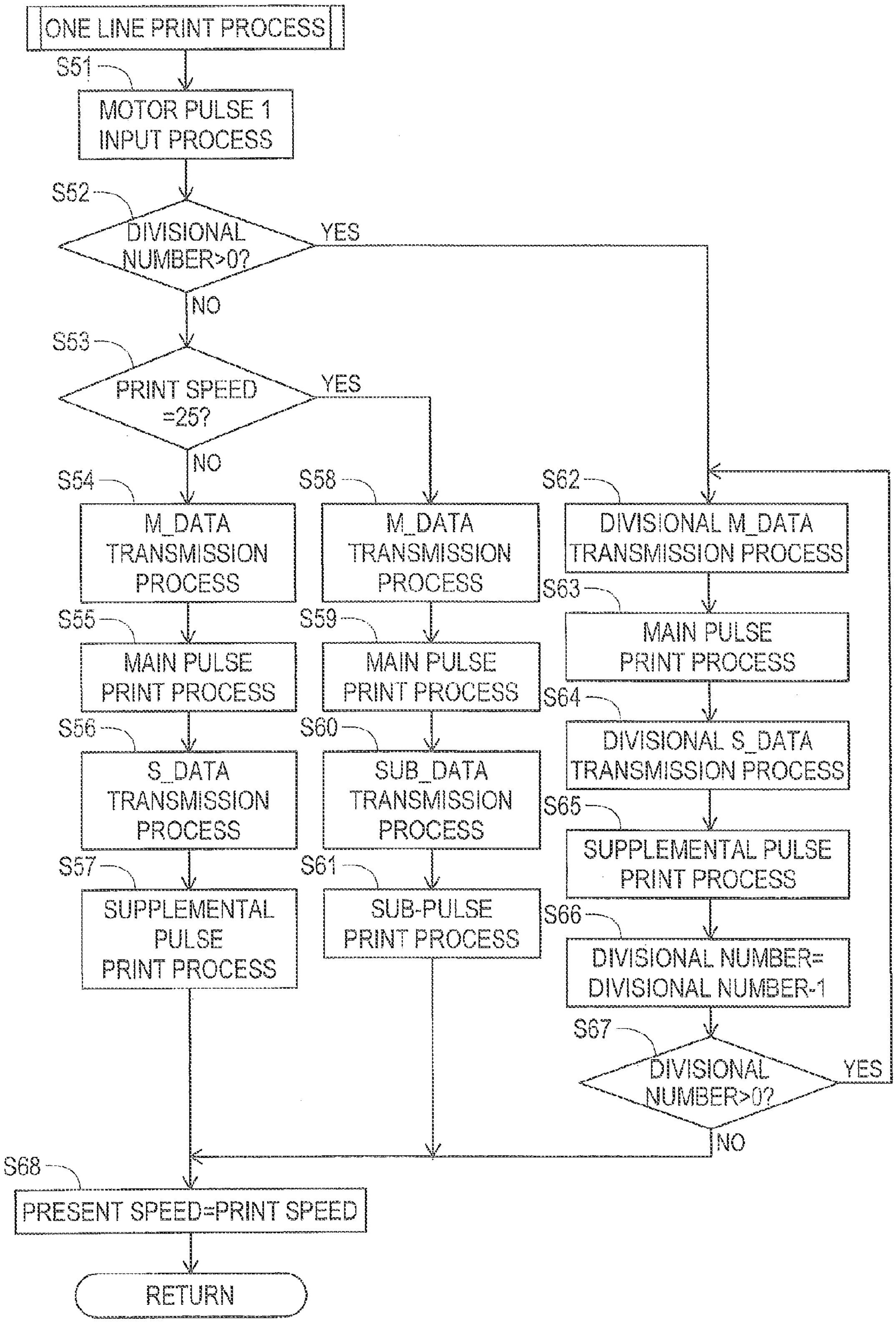

TARGET SPEED JUDGMENT PROCESS
S41
M>A?
NO
YES
S44
S>A?
NO
YES
S42
DIVISIONAL NUMBER:M(N)/A
S45
DIVISIONAL NUMBER:0
S47
DIVISIONAL NUMBER:0
S43
TARGET SPEED:9
S46
TARGET SPEED:24
S48
TARGET SPEED:25
RETURN

FIG. 12


ONE LINE PRINT PROCESS
S51
MOTOR PULSE 1 INPUT PROCESS
S52
DIVISIONAL NUMBER>0?
YES
NO
S53
PRINT SPEED =25?
YES
NO
S54
M_DATA TRANSMISSION PROCESS
S55
MAIN PULSE PRINT PROCESS
S56
S_DATA TRANSMISSION PROCESS
S57
SUPPLEMENTAL PULSE PRINT PROCESS
S58
M_DATA TRANSMISSION PROCESS
S59
MAIN PULSE PRINT PROCESS
S60
SUB_DATA TRANSMISSION PROCESS
S61
SUB-PULSE PRINT PROCESS
S62
DIVISIONAL M_DATA TRANSMISSION PROCESS
S63
MAIN PULSE PRINT PROCESS
S64
DIVISIONAL S_DATA TRANSMISSION PROCESS
S65
SUPPLEMENTAL PULSE PRINT PROCESS
S66
DIVISIONAL NUMBER= DIVISIONAL NUMBER-1
S67
DIVISIONAL NUMBER>0?
YES
NO
S68
PRESENT SPEED=PRINT SPEED
RETURN

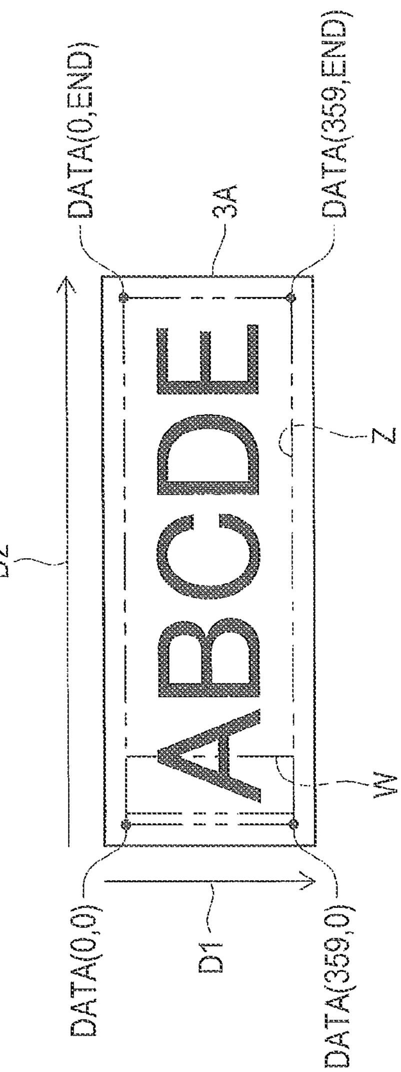


FIG. 13

FIG. 14

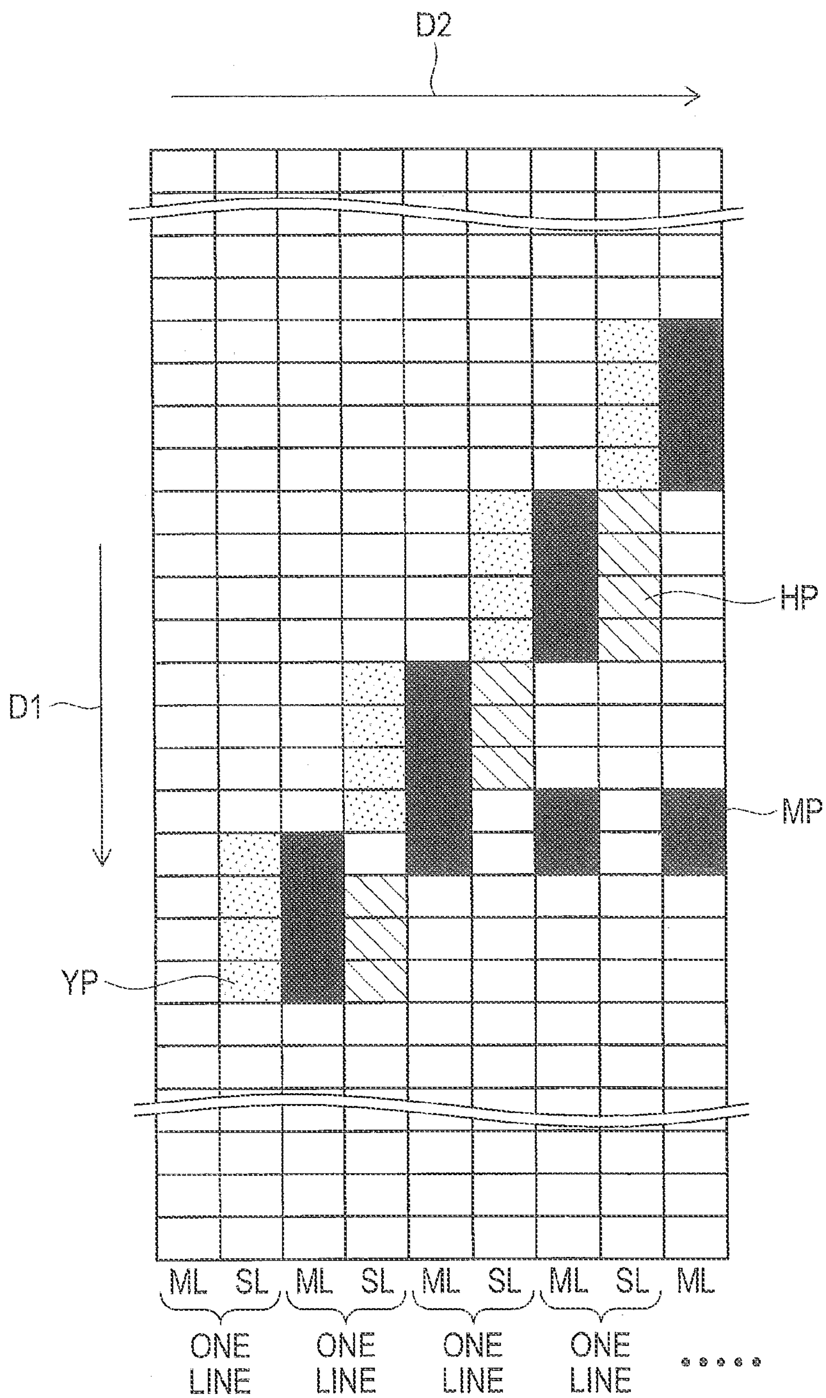

D2
D1
HP
MP
YP
ML SL ML SL ML SL ML SL ML
ONE LINE
ONE LINE
ONE LINE
ONE LINE
.....

FIG. 15

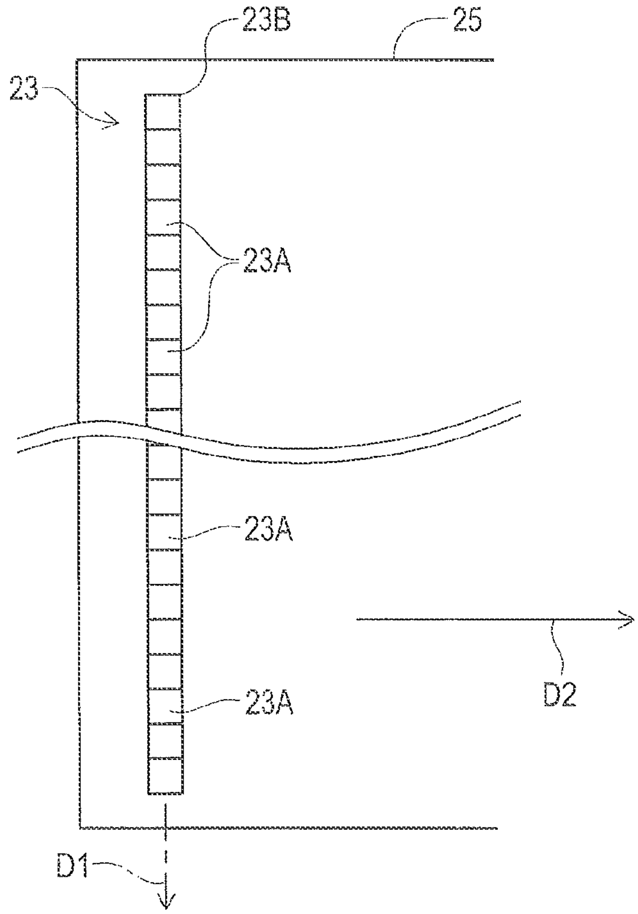


FIG. 16

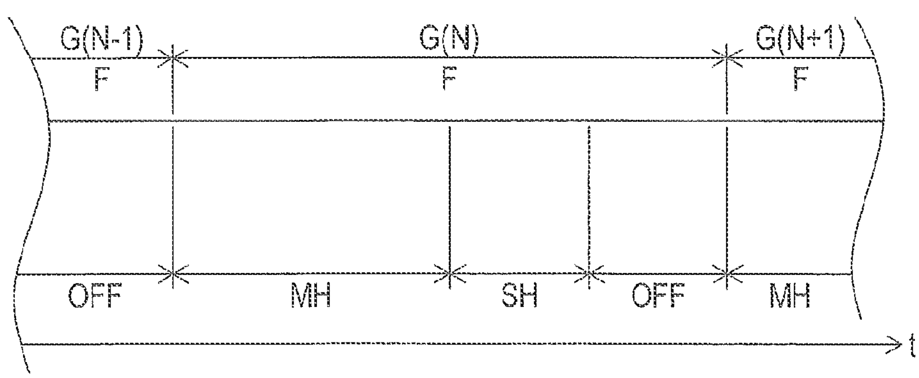
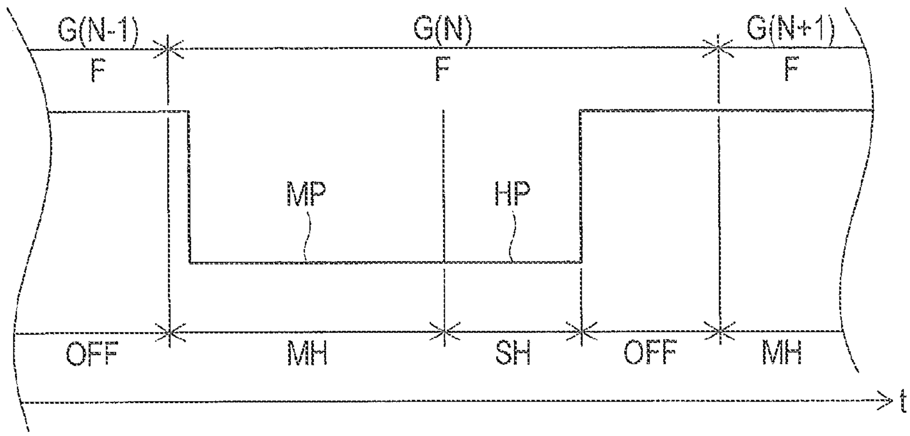
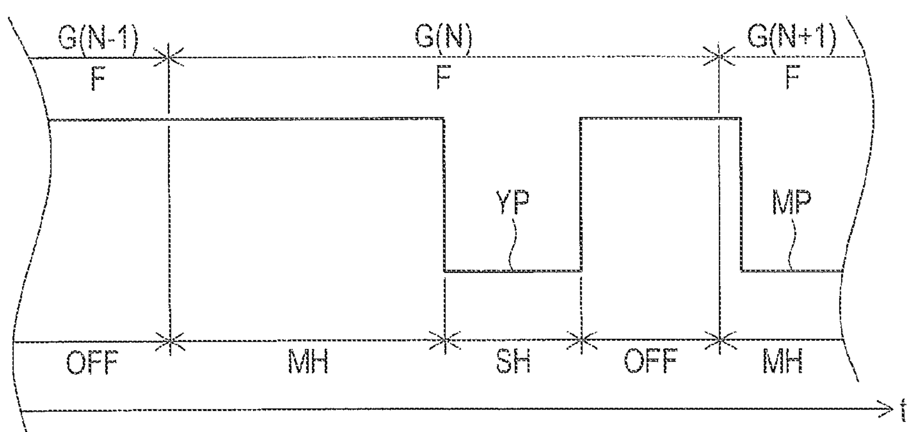


FIG. 17



SUPPLEMENTAL PULSE HP

FIG. 18



PREHEAT PULSE YP

FIG. 19

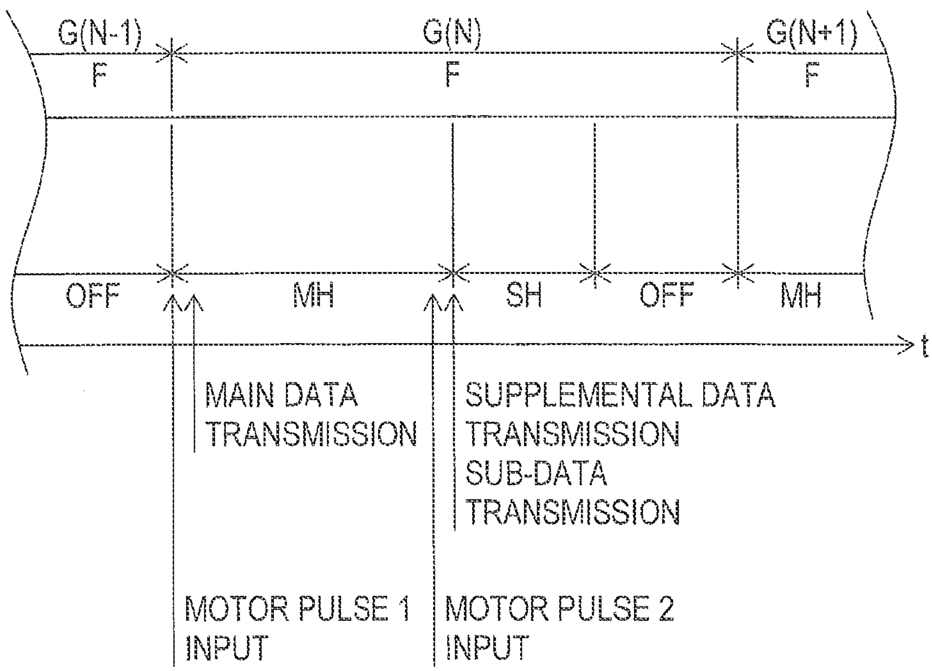

G(N-1)
F
G(N)
F
G(N+1)
F
OFF
MH
SH
OFF
MH
t
MAIN DATA TRANSMISSION
SUPPLEMENTAL DATA TRANSMISSION
SUB-DATA TRANSMISSION
MOTOR PULSE 1 INPUT
MOTOR PULSE 2 INPUT

FIG. 20

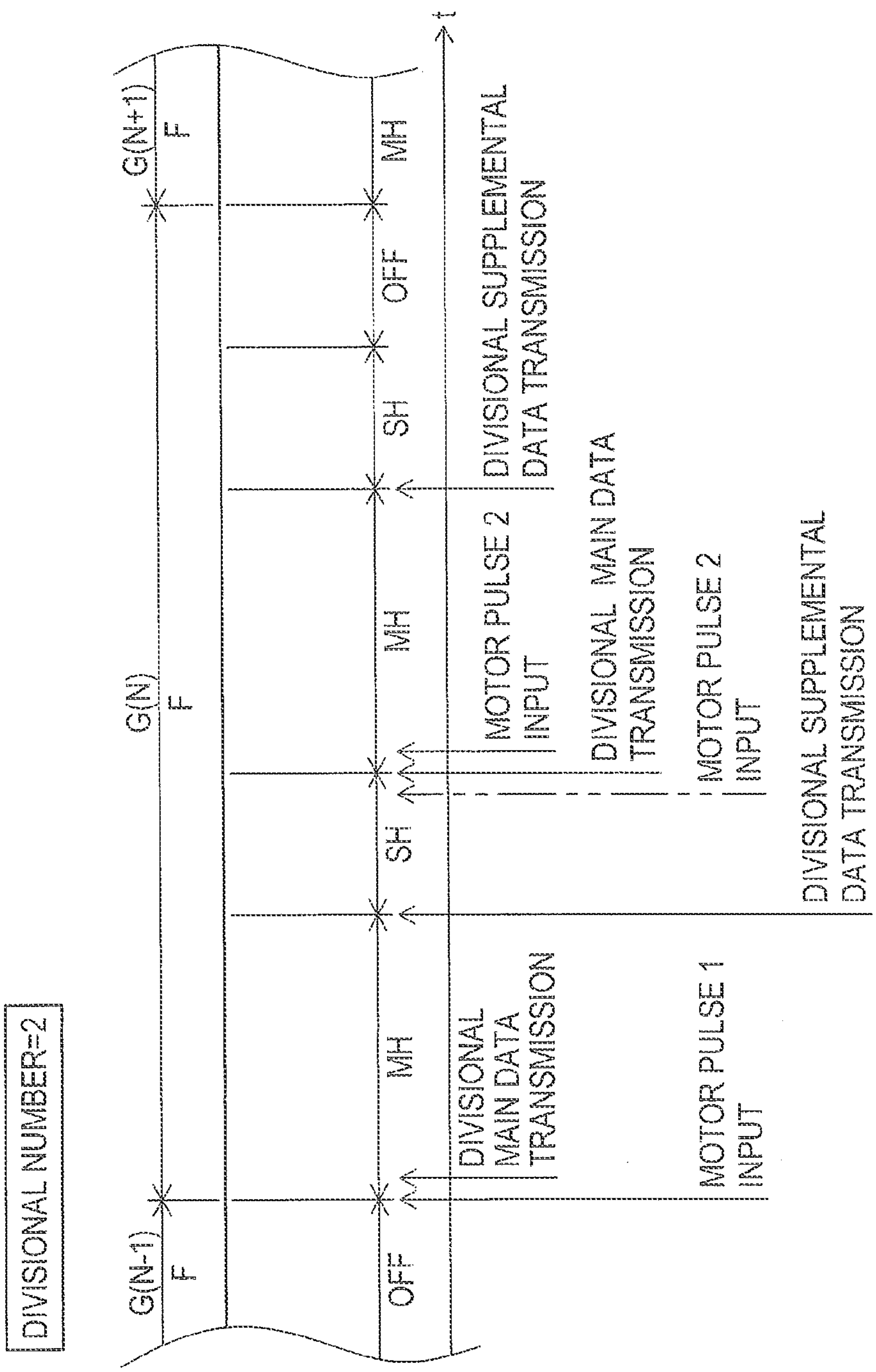

DIVISIONAL NUMBER=2
G(N-1)
F
G(N)
F
G(N+1)
F
OFF
MH
SH
MH
SH
OFF
MH
t
DIVISIONAL MAIN DATA TRANSMISSION
MOTOR PULSE 1 INPUT
DIVISIONAL SUPPLEMENTAL DATA TRANSMISSION
MOTOR PULSE 2 INPUT
DIVISIONAL MAIN DATA TRANSMISSION
MOTOR PULSE 2 INPUT
DIVISIONAL SUPPLEMENTAL DATA TRANSMISSION

FIG. 21

TABLE FOR SPEED AND PRINTING

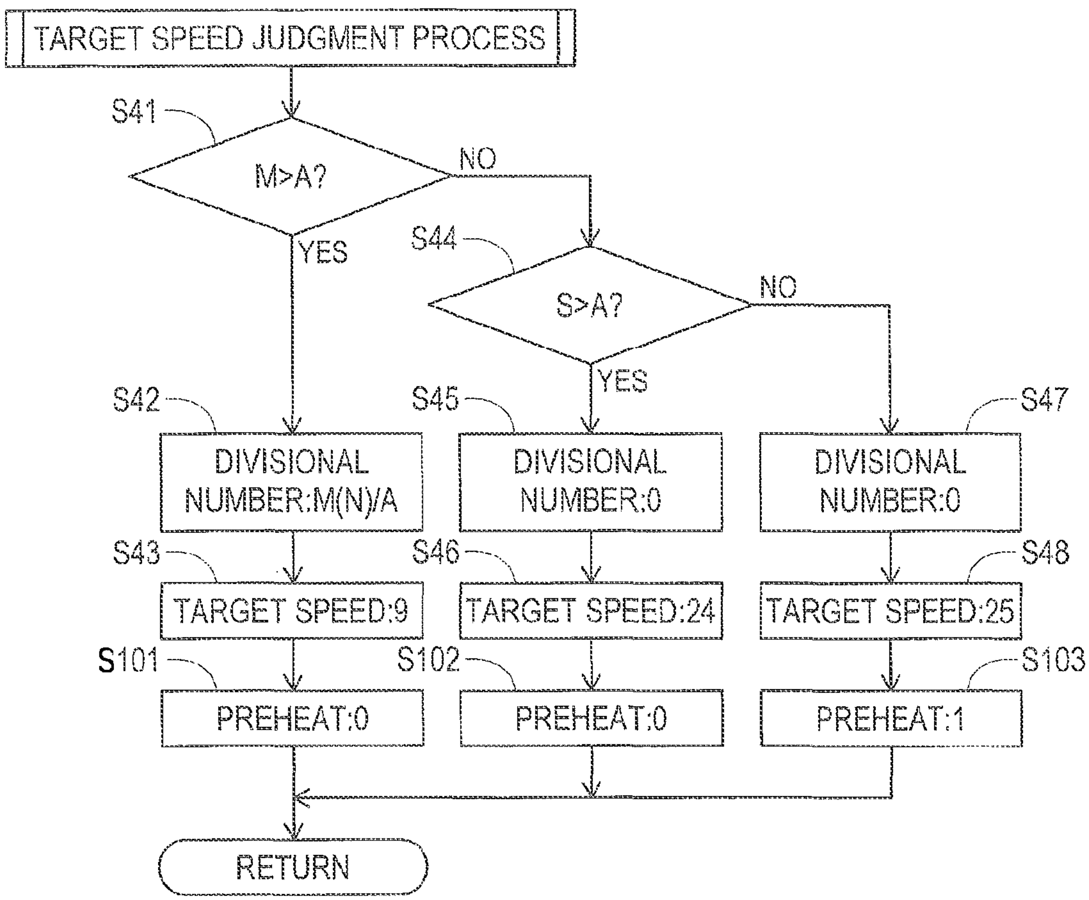
NUMBER	SPEED mm/s	PRINT PULSE	DIVISIONAL PRINTING
0	0	MAIN PULSE + SUPPLEMENTAL PULSE	○
1	2	MAIN PULSE + SUPPLEMENTAL PULSE	○
2	4	MAIN PULSE + SUPPLEMENTAL PULSE	○
3	6	MAIN PULSE + SUPPLEMENTAL PULSE	○
4	9	MAIN PULSE + SUPPLEMENTAL PULSE	○
5	11	MAIN PULSE + SUPPLEMENTAL PULSE	○
6	14	MAIN PULSE + SUPPLEMENTAL PULSE	○
7	17	MAIN PULSE + SUPPLEMENTAL PULSE	○
8	27	MAIN PULSE + SUPPLEMENTAL PULSE	○
9	30	MAIN PULSE + SUPPLEMENTAL PULSE	○
10	34	MAIN PULSE + SUPPLEMENTAL PULSE	-
11	43	MAIN PULSE + SUPPLEMENTAL PULSE	-
12	50	MAIN PULSE + SUPPLEMENTAL PULSE	-
13	56	MAIN PULSE + SUPPLEMENTAL PULSE	-
14	62	MAIN PULSE + SUPPLEMENTAL PULSE	-
15	66	MAIN PULSE + SUPPLEMENTAL PULSE	-
16	72	MAIN PULSE + SUPPLEMENTAL PULSE	-
17	76	MAIN PULSE + SUPPLEMENTAL PULSE	-
18	81	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-
19	87	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-
20	93	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-
21	98	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-
22	102	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-
23	106	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-
24	110	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-
25	114	MAIN PULSE + SUB-PULSE (SUPPLEMENTAL PULSE + PREHEAT PULSE)	-

FIG. 22

ACCELERATION-DECELERATION TABLE

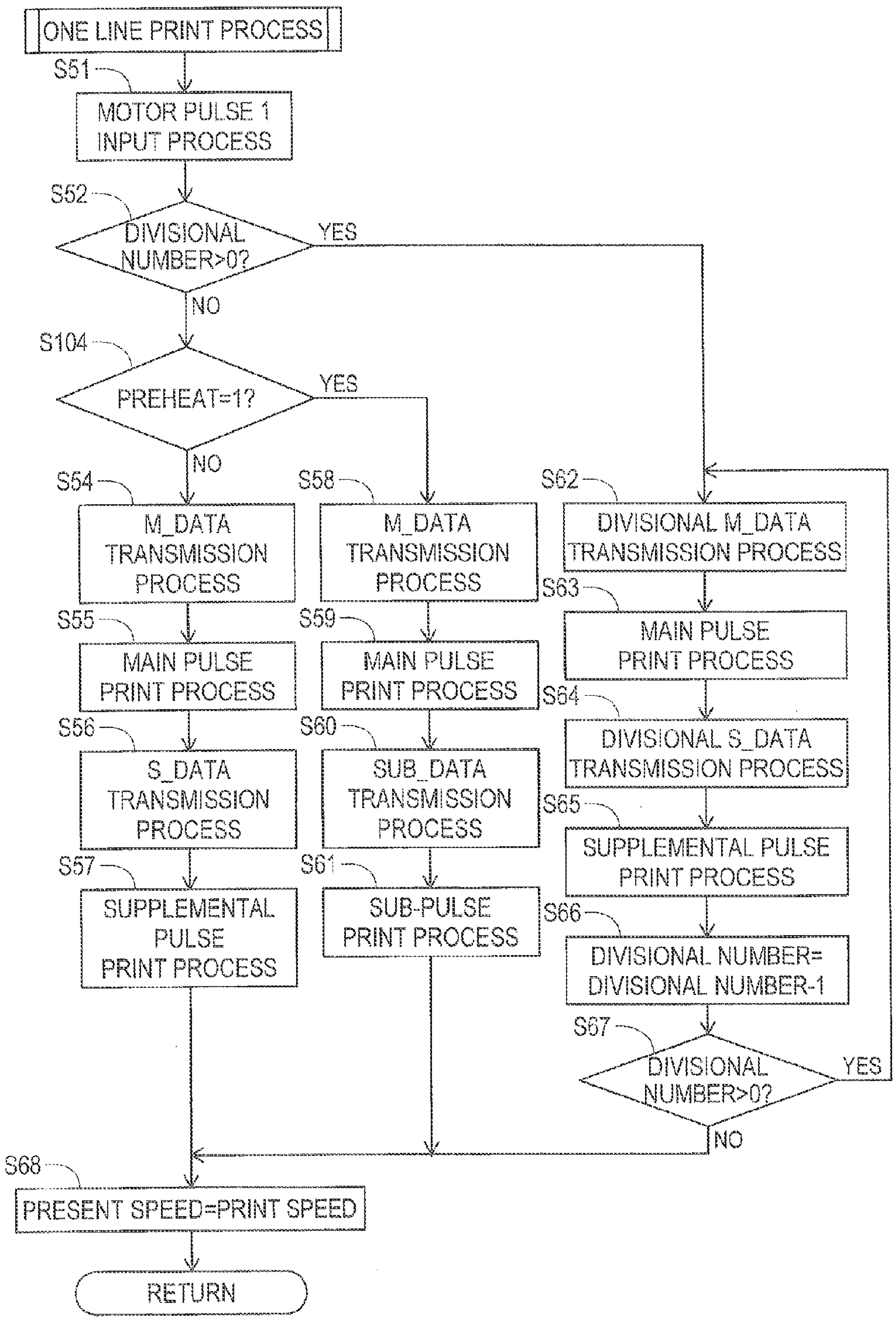
PRINT SPEED		PRESENT SPEED																									
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
TARGET SPEED	0	0	0	0	0	0	0	0	0	0	0	0	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	1	1	1	1	1	1	1	1	1	1	1	1	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	2	2	2	2	2	2	2	2	2	2	2	2	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	3	3	3	3	3	3	3	3	3	3	3	3	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	4	4	4	4	4	4	4	4	4	4	4	4	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	5	5	5	5	5	5	5	5	5	5	5	5	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	6	6	6	6	6	6	6	6	6	6	6	6	6	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	7	7	7	7	7	7	7	7	7	7	7	7	7	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	11	12	14	15	16	17	18	19	20	21	22	23
	9	9	9	9	9	9	9	9	9	9	9	9	9	9	10	11	12	14	15	16	17	18	19	20	21	22	23
	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	12	14	15	16	17	18	19	20	21	22	23
	11	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11	12	14	15	16	17	18	19	20	21	22	23
	12	10	10	10	10	10	10	10	10	10	12	12	12	12	12	12	12	14	15	16	17	18	19	20	21	22	23
	13	10	10	10	10	10	10	10	10	10	12	13	13	13	13	13	13	14	15	16	17	18	19	20	21	22	23
	14	10	10	10	10	10	10	10	10	10	12	13	14	14	14	14	14	14	15	16	17	18	19	20	21	22	23
	15	10	10	10	10	10	10	10	10	10	12	13	14	15	15	15	15	15	15	16	17	18	19	20	21	22	23
	16	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	16	16	16	16	17	18	19	20	21	22	23
	17	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	17	17	17	17	18	19	20	21	22	23
	18	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	18	18	18	19	20	21	22	23
	19	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	19	19	19	20	21	22	23
	20	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	20	20	20	21	22	23
	21	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	21	21	21	22	23
	22	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	22	22	22	22	23
	23	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	22	23	23	23	23
	24	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	22	23	24	24	24
	25	10	10	10	10	10	10	10	10	10	12	13	14	15	16	16	17	18	18	19	20	21	22	23	24	25	25

FIG. 23



TARGET SPEED JUDGMENT PROCESS
S41
M>A?
NO
YES
S44
S>A?
NO
YES
S42
DIVISIONAL NUMBER:M(N)/A
S45
DIVISIONAL NUMBER:0
S47
DIVISIONAL NUMBER:0
S43
TARGET SPEED:9
S46
TARGET SPEED:24
S48
TARGET SPEED:25
S101
PREHEAT:0
S102
PREHEAT:0
S103
PREHEAT:1
RETURN

FIG. 24


ONE LINE PRINT PROCESS
S51
MOTOR PULSE 1 INPUT PROCESS
S52
DIVISIONAL NUMBER>0?
YES
NO
S104
PREHEAT=1?
YES
NO
S54
M_DATA TRANSMISSION PROCESS
S55
MAIN PULSE PRINT PROCESS
S56
S_DATA TRANSMISSION PROCESS
S57
SUPPLEMENTAL PULSE PRINT PROCESS
S58
M_DATA TRANSMISSION PROCESS
S59
MAIN PULSE PRINT PROCESS
S60
SUB_DATA TRANSMISSION PROCESS
S61
SUB-PULSE PRINT PROCESS
S62
DIVISIONAL M_DATA TRANSMISSION PROCESS
S63
MAIN PULSE PRINT PROCESS
S64
DIVISIONAL S_DATA TRANSMISSION PROCESS
S65
SUPPLEMENTAL PULSE PRINT PROCESS
S66
DIVISIONAL NUMBER= DIVISIONAL NUMBER-1
S67
DIVISIONAL NUMBER>0?
YES
NO
S68
PRESENT SPEED=PRINT SPEED
RETURN

PRINTING DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims priority from Japanese Patent Application No. JP 2014-074309, which was filed on Mar. 31, 2014, and Application No. JP 2014-082886, which was filed on Apr. 14, 2014, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates to a printing device in which a desirable print formation is done on a print medium.

Conventionally, in a printing device in which a desirable print formation is done on a print medium, when it is necessary to add simultaneously print pulses to a plurality of heat elements of a thermal head, for instance, under condition that ruled lines or black areas are printed, it is conducted divisional printing explained below.

In the divisional printing, a divisional number is determined according to the maximum value of on-dot number defined by a total number of heat elements to which print pulses are simultaneously added in a thermal head, and print pulses are added to the heat elements of thermal head every each of a plurality of divided heating areas, along a main scanning direction intersecting a feed direction of the print medium at right angle based on the above divisional number.

When the above divisional printing is conducted, the feed speed of print medium goes down to a comparatively low speed.

Here, among print pulses added to the heat elements of thermal head, there exists a main pulse to conduct color development on the print medium and a sub-pulse to supplement the main pulse.

Furthermore, the sub-pulse includes a supplemental pulse, which cannot conduct color development on the print medium when added alone but can conduct color development on the print medium by supplementing the main pulse added during the present print period, and a preheat pulse, which cannot conduct color development on the print medium when added alone but can conduct color development on the print medium by supplementing the main pulse added during the next print period.

Especially, in case that the heat elements to which the preheat pulses are added, are included in count object of on-dot number of dots which are simultaneously heated on in determination of the divisional number, it may be conceivable that a number of times that divisional printing is done increase. Accordingly, it may be conceivable that feed speed of the print medium becomes comparatively slow and such time becomes long. As a result, it may occur a case that realization of fast print is difficult.

SUMMARY

The disclosure has been made to solve the above-described problem and has an object to provide a printing device in which fast print can be realized even if the supplemental pulse or preheat pulse is utilized in the printing device in which divisional printing may occur.

To achieve the purpose of the disclosure, there is provided a printing device comprising: a thermal head provided with a line head in which a plurality of heat elements are linearly lined up; a feeding device for feeding a thermal print medium in a sub-scanning direction normal to the line head of the thermal head; a control device for controlling the feeding device and the thermal head; wherein the control device conducts batch processing or divisional processing of pulse addition to selectively heat the heat elements in the line head of the thermal head in a main scanning direction parallel with the line head every a print period continuously repeated, thereby printing of print dots is done on the thermal print medium fed in sub-scanning direction by the feeding device in accordance with a feed speed corresponding to the batch processing or a feed speed corresponding to the divisional processing, wherein a main pulse adding time of the main pulse to color-develop the thermal print medium and a sub-pulse adding time to supplement the main pulse are retained in each of the print period, wherein the sub-pulse is a supplemental pulse color-developing the thermal print medium by supplementing the main pulse added in a present print period, the supplemental pulse not being able to color-develop the thermal print medium by itself or a preheat pulse to color-develop the thermal print medium by supplementing the main pulse added in a next print period, the preheat pulse not being able to color-develop the thermal print medium by itself, wherein the control device counts a total number of the main pulse every print period within a first predetermined range, and when a maximum value of the total number of the main pulse exceeds a first threshold value, the divisional processing is conducted by adding the main pulse and the supplemental pulse every the print period within a second predetermined range smaller than the first predetermined range in accordance with the feed speed corresponding to the divisional processing, wherein when the maximum value of the total number of the main pulse does not exceed the first threshold, the control device counts a total number of the supplemental pulse every the print period within the first predetermined range, and when the maximum value of the total value of the supplemental pulse exceeds a second threshold value, the batch processing is conducted by adding the main pulse and the supplemental pulse every the print period within the second predetermined range in accordance with the feed speed corresponding to the batch processing, and wherein when the total value of the supplemental pulse does not exceed the second threshold value, the batch processing is conducted by adding the main pulse and the supplemental pulse every the print period within the second predetermined range at the feed speed corresponding to the batch processing and the batch processing is conducted by adding the main pulse, the supplemental pulse and the preheat pulse every the print period within the second predetermined range while the feed speed shifts to a maximum speed by exceeding the feed speed corresponding to the batch processing.

Here, "color development" is not limited to color development occurring in heat-sensitive printing and includes color development occurring in thermal transcription printing. Further, "first threshold value" and "second threshold value" may be equal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view indicating an outline of a printing device according to one embodiment of the disclosure.

FIG. **2** is a perspective view of the printing device when an upper cover is open.

FIG. **3** is a side cross section along a front-rear direction of the printing device.

FIG. **4** is a functional block diagram indicating a control system of the printing device.

FIG. **5** is a preset line number table stored in ROM.

FIG. **6** is a dot-number table stored in ROM.

FIG. **7** is a table indicating a relation between speed and printing stored in ROM.

FIG. **8** is an acceleration-deceleration table stored in ROM.

FIG. **9** is a main flowchart indicating control procedure executed by CPU.

FIG. **10** is a sub-flowchart indicating control procedure executed by CPU.

FIG. **11** is a sub-flowchart indicating control procedure executed by CPU.

FIG. **12** is a sub-flowchart indicating control procedure executed by CPU.

FIG. **13** is an explanatory view indicating a printed example of print tape.

FIG. **14** is a an explanatory view indicating additional state of a main pulse, a supplement-pulse and a preheat-pulse in each line among plural lines each of which lines up in sub-scanning direction and parallel with main-scanning direction.

FIG. **15** is an enlarged view of a thermal head.

FIG. **16** is an explanatory view indicating a print period.

FIG. **17** is an explanatory view indicating the main pulse and the supplemental pulse.

FIG. **18** is an explanatory view of the main pulse and the preheat pulse.

FIG. **19** is an explanatory view indicating a timing according to which a motor pulse is input and data are transmitted.

FIG. **20** is an explanatory view indicating a timing according to which a motor pulse is input and data are transmitted.

FIG. **21** is a table indicating a relation between speed and printing stored in ROM.

FIG. **22** is an acceleration-deceleration table stored in ROM.

FIG. **23** is a sub-flowchart indicating control procedure executed by CPU.

FIG. **24** is a sub-flowchart indicating control procedure executed by CPU.

DETAILED DESCRIPTION

A detailed description of an exemplary embodiment of the printing device embodying the disclosure will now be given referring to the accompanying drawings.

Hereinafter, one embodiment of the present disclosure will be explained with reference to drawings.

[Construction of Printing Device]

An outline construction of one embodiment according to the present disclosure will be described with reference to FIGS. **1** to **3**. As shown in FIG. **1**, the printing device **1** of the embodiment has a case **2** and an upper cover **5**. In front of the case **2**, a resin-made tray **6** is up-raised at a front end portion continuing to the upper cover **5**, and a power button **7** is arranged at a forward position of the tray **6**. Under the power button **7**, a cutter lever **9** to operate a cutter unit **8** (see FIG. **3**) and conduct cutting operation is arranged. The cutter lever **9** is provided so as to be movable in a width direction of the case **2** (right and left direction).

As shown in FIG. **2**, at left side of the case **2**, an operation lever **21** to lift-up and lift-down a thermal head **23** (see FIG. **3**) is provided so as to be rotatable in up and down direction. At rear side of the case **2**, a power supply code **10** (see FIG. **3**) is connected and connector portion (not shown) constructed from USB (Universal Serial Bus) used for connecting with a personal computer **26** (see FIG. **4**) and so on is provided. The upper cover **5** is connected to the case **2** at the rear end portion thereof, so that the upper cover **5** becomes rotatable, thereby the upper cover **5** has structure so as to be able to open and close the case **2**.

As shown in FIGS. **1** and **2**, the printing device **1** has a holder storing portion **4** formed in a concave shape arranged at a rear position of inner space of the case **2**. On the holder storing portion **4**, a roll holder **3**B in which a roll **3** of print tape **3**A (print medium) is provided, is stored so that roll width direction of the roll **3** coincides with a width direction of the case **2** and the print tape **3**A is fed from the upper side thereof. The print tape **3**A is formed from a long thermal sheet (so-called, thermal paper) having printing layer with self-coloring ability or a long label sheet on one side of which a release sheet is stacked through an adhesive layer for adhering to an object body. Such print sheet **3**A is rolled around a roll core, thereby the roll **3** is formed.

The roll holder **3**B has a guide member **13** arranged at one side (left side in FIG. **2**) in the width direction of the roll **3**, a retaining member **12** arranged at the other side (right side in FIG. **2**) in the width direction of the roll **3** and a shaft member (not shown) connecting the retaining member **12** and the guide member **13**. The roll core of the roll **3** is inserted in the shaft member while the guide member **13** is detached. The guide member **13** is fixed to one side end portion of the roll core protruded from the shaft member in the width direction of the roll **3**. Thereby, the one side end portion in the width direction of the roll **3** is contacted with the guide member **13** and the roll **3** is rotatably disposed to the roll holder **3**B around the shaft member, while the other side end portion of the roll **3** is contacted with the retaining member **12**.

The guide member **13** of roll holder **3**B has a guide portion **13**A for guiding the print tape **3**A which is repeatedly fed from the roll **3**, the guide portion **13**A being extended to a tape feed direction. A lower end of the guide portion **13**A is formed so as to a horizontal plane. On the other hand, at a front of the holder storing portion **4**, a horizontal portion **20** to put the guide portion **13**A thereon is formed. At the other end side of the holder storing portion **4** in the roll width direction, as shown in FIG. **2**, a holder support member **15** is stood up, the holder support member **15** having a positioning groove **16** with a long-hole shape opened in upward direction. When the roll holder **3**B is inserted in the holder storing portion **4**, the guide portion **13**A of the guide member **13** is put on the horizontal portion **20** of the holder storing portion **4** and a protrusive portion **12**A horizontally protruded from the retaining member **12** is fit in the positioning groove **16** formed in the holder support member **15**. Thereby, the roll holder **3**A is detachably mounted in the holder storing portion **4**.

As shown in FIG. **3**, at a downstream side in the tape feed direction of the horizontal portion **20** formed in the front part of the holder storing portion **4**, the thermal head **23** is positioned which is arranged so as to be able to move up and down direction. At an upper direction of the thermal head **23**, a platen roller **22** is positioned so as to face to the thermal head **23**. The front portion of the holder storing portion **4** forward extends while bending toward the lower direction and continues to an insertion opening **18** to insert the print tape **3**A rewound and fed from the roll **3** into a space where the platen roller **22** and the thermal head **23** are faced each other.

The platen roller **22** grasps the print tape **3**A from the roll **3** in cooperation with the thermal head **23** moved upward and feeds the print tape **3**A by being driven to rotate through a pulse motor **24** (see FIG. **4**).

The thermal head **23** forms dots on each of print lines which are sectioned according to print resolution in the tape feed direction of the print tape **3**A. That is to say, as shown in FIG. **15**, the thermal head **23** has a plurality of heat elements **23**A (360 elements) arranged parallel with a main-scanning direction D**1** normal to a sub-scanning direction D**2** coinciding with the tape feed direction. The thermal head **23** is constructed from a line head **23**B in which 360 heat elements **23**A are arranged in one line and a plate **25** on which the line head **23**B is provided.

Returning to FIGS. **2** and **3**, description will be continued. The thermal head **23** conducts printing based on image data on a print layer (lower surface) of the print tape **3**A grasped by the platen roller **22** therebetween by electrically turning on the heat elements **23**A (see FIG. **15**) based on the image data. Here, the thermal head **23** is moved downward by rotating upward the operation lever **21** arranged at the left side of the case **2**, thereby the thermal head **23** separates from the platen roller **22**. Contrarily, when the operation lever **21** is rotated downward, the thermal head **23** is moved upward and contacted with the platen roller **22** through the print tape **3**A therebetween, thereby the printer **1** becomes a printable state.

At the downstream side in the tape feed direction from the thermal head **23**, the cutter unit **8** is arranged which is movable in the width direction of the print tape **3**A. After printing is done by the thermal head **23** and the cutter lever **9** is moved in the width direction of the case **2**. Thereby, the cutter unit **8** moves in the width direction of the print tape **3**A and cuts the print tape **3**A in the width direction of the print tape **3**A after printing is done on the print tape **3**A and the print tape **3**A is discharged on the tray **6**.

[Print Operation]

Hereinafter, print operation of the printing device **1** will be described. First, the operation lever **21** is rotated upward and the thermal head **23** is positioned in a state that the thermal head **23** is separated downward from the platen roller **22**. In this state, the roller holder **3**B on which the roll **3** is provided is put on the holder storing portion **4** and the protrusive portion **12**A of the retaining member **12**A in the roll holder **3**B is fit into the positioning groove **16** of the holder support member **15**. Thereafter, the lower surface of the guide portion **13**A of the guide member **13** in the roll holder **3**A is contacted with the horizontal portion **20** and the roll holder **3**A in which the roll **3** is set is stored detachably from the holder storing portion **4**.

Thereafter, while end portion at one side in the width direction of the print tape **3**A is contacted with inner side of the guide member **13**, the print tape **3**A is derived from the roll **3** and while the other end portion in the width direction of the derived print tape **3**A is contacted with the other side peripheral in the roll width direction of the insertion opening **18**, the print tape **3**A is inserted in the insertion opening **18**. The top portion of the print tape **3**A in the tape feed direction is positioned between the platen roller **22** and the thermal head **23**. Thereafter, the upper cover **5** is closed so as to cover the upper side of the holder storing portion **4** (see the state shown in FIG. **1**).

When the upper cover **5** is closed, the upper cover **5** presses the operation lever **21**, thereby the operation lever **21** rotates downward and the thermal head **23** is positioned in a state that the thermal head **23** depresses the print tape **3**A onto the platen roller **22**. When the platen roller **22** is driven to rotate by the pulse motor **24** (see FIG. **4**), the print tape **3**A is fed by the platen roller **22**. Thereafter, when the heat elements **23**A (see FIG. **25**) on the thermal head **23** are electrically turned on, printing is serially conducted on the print layer of the print tape **3**A by the heat elements **23**A (see FIG. **15**) based on the image data. The print tape **3**A passed through the thermal head **23** is discharged to the tray **6** through a clearance between the upper cover **5** and the case **2**. At a time that printing onto the print tape **3**A is done and discharged length of the print tape **3**A from the cutter unit **8** becomes a predetermined length, the cutter lever **9** is operated and moved to the rightward direction. Thereby, the print tape **3**A is cut in the width direction thereof and a label (printed tape), on which predetermined printing is done, with a predetermined length is formed.

Here, on the print tape **3**A shown in FIG. **13**, English characters "ABCD" are printed. The width direction of the print tape **3**A corresponds to the main-scanning direction D**1** parallel with the arrangement direction of the heat elements **23**A (see FIG. **15**) of the thermal head **23**. The feed direction of the print tape **3**A is the sub-scanning direction D**2** perpendicular to the arrangement direction of the heat elements **23**A (see FIG. **15**) of the thermal head **23**.

[Control System]

Hereinafter, the control system of the printing device **1** according to the embodiment will be described with reference to FIG. **4**. In FIG. **4**, a control circuit **210** is arranged in the control system of the printing device **1**. In the control circuit **210**, CPU **27**, ROM **28** and SRAM **29** are connected to the CPU **27**. To the CPU **27**, motor drive circuit **31** and thermal head control circuit **32** are connected through interface **30**. Further, to the CPU **27**, personal computer **26** as an outer device is connected. To the motor drive circuit **31**, the pulse motor **24** is connected and to the thermal head control circuit **32**, the thermal head **23** is connected. Here, in the present embodiment, as for the pulse motor **24**, it will be described according to a case that the pulse motor **24** corresponds to "1 line-2 motor pulses". That is to say, "1 line-2 motor pulses" means a case that when 2 motor pulses are added to the pulse motor **24**, the print tape **3**A is fed by only 1 line of the print lines based on print resolution in the tape feed direction by rotation of the platen roller **22**. However, the pulse motor **24** is not limited to "1 line-2 motor pulses" and another correspondence relation such as "1 line-1 motor pulse" and so on may be conceivable.

In the ROM **28**, a preset line number table **33**, a dot number table **35**, a table for speed and printing **36** and an acceleration-deceleration table **37** are stored therein. Here, these preset line number table **32**, dot number table **35**, table **36** for speed and printing and acceleration-deceleration table **37** will be described hereinafter.

Further, in the ROM **28**, programs of flowcharts represented in FIGS. **9**-**12**, **23** and **24** will be described hereinafter.

SRAM **29** is a temporary memory for temporarily storing data necessary to conduct data process by the CPU **27**, and the SRAM **29** has a print buffer **40**, a print data memory **41** and a work area **43**.

In the print buffer **40**, image data transmitted from the personal computer **26** is stored. The image data is a two-dimensional data groups in which, in a print area Z shown in FIG. **13**, the dot color-developed on a print line (abbreviated as "color-development dot" hereinafter) is represented as "1" and the dot non-color-developed on a print line (abbreviated as "non-color-development dot" hereinafter) is represented as "0". In the embodiment, the two-dimensional data groups are specified through coordinate DATA(X, Y) within the print area Z.

The coordinate DATA(X, Y) in the print area Z is represented based on that the main-scanning direction D**1** is X direction, the sub-scanning direction D**2** is Y direction, and the left upper corner in the print area Z is origin DATA(0,0). Here, 360 heat elements on the thermal head **23** (see FIG. **15**) are arranged parallel with the X direction corresponding to the main-print scanning direction. The left side of the print area Z corresponds to the first print line and the right side (downstream side in the tape feed direction) of the print area Z corresponds to the last print line. Further, position in Y direction on the first print line is represented as "0". In the embodiment, position on the last print line in Y-direction is represented as the variable "END". Based on the above, as shown in FIG. **13**, the position of left upper corner in the print area Z is represented as DATA(0,0), the position of left lower corner in the print area Z is represented as DATA(359,0), the position of right upper corner in the print area Z is represented as DATA(0, END) and the position of right lower corner in the print area Z is represented as DATA(359, END).

Returning to FIG. **4**, a print data memory **41** stores main data M_DATA(X, Y), supplemental data S_DATA(X, Y), preheat data P_DATA(X, Y) and sub-data SUB_DATA(X, Y), these data being used and formed in the flowchart in FIG. **10**.

The main data M_DATA(X, Y) is the two-dimensional data groups in which the dot on the print line in the print area Z (see FIG. **13**) that a main pulse is added is represented as "1", the dot on the print line in the print area Z (see FIG. **13**) that the main pulse is not added is represented as "0", both dots being represented by the coordinate DATA(X, Y) within the print area Z. As mentioned later, the dot on the print line to which the main pulse is added is the "color-development dot" and the dot on the print line to which the main pulse is not added is the "non-color-development dot". Thus, the main data M_DATA(X, Y) coincides with the image data as the two-dimensional data groups transmitted from the personal computer **26**.

The supplemental data S_DATA(X, Y) is the two-dimensional data groups in which the dot on the print line in the print area Z (see FIG. **13**) that a supplemental pulse is added is represented as "1", the dot on the print line in the print area Z (see FIG. **13**) that the supplemental pulse is not added is represented as "0", both dots being represented by the coordinate DATA(X, Y) within the print area Z. The preheat DATA P_(X, Y) is the two-dimensional data groups in which the dot on the print line in the print area Z (see FIG. **13**) that a preheat pulse is added is represented as "1", the dot on the print line in the print area Z (see FIG. **13**) that the preheat pulse is not added is represented as "0", both dots being represented by the coordinate DATA(X, Y) within the print area Z. The sub-data SUB_DATA(X, Y) is the two-dimensional data groups in which the dot on the print line in the print area Z (see FIG. **13**) that the sub-pulse is added is represented as "1", the dot on the print line in the print area Z (see FIG. **13**) that the sub-pulse is not added is represented as "0", both dots being represented by the coordinate DATA(X, Y) within the print area Z.

The main pulse, the supplemental pulse, the preheat pulse and the sub-pulse will be described with reference to FIGS. **16** to **18**.

In FIGS. **16** to **18**, a time axis is represented as "t" and a print period for one print line is represented as "F".

In FIG. **16**, G(N) indicates a print period of dot positioned at a position represented coordinate DATA(X, Y) within the print area Z (see FIG. **13**) among dots existing on the present print line.

G(N−1) indicates a print period of dot positioned at a position represented coordinate DATA(X, Y−1) within the print area Z (see FIG. **13**) among dots existing on the previous print line. That is to say, the dot corresponding to the previous print period G(N−1) positions at an adjacent position of upstream side in the tape feed direction parallel with the sub-scanning direction D**2** (see FIG. **13**) concerning the dot corresponding to the present print period G(N).

G(N+1) indicates a print period of dot positioned at a position represented coordinate DATA(X, Y+1) within the print area Z (see FIG. **13**) among dots existing on the next print line. That is to say, the dot corresponding to the next print period G(N+1) positions at an adjacent position of downstream side in the tape feed direction parallel with the sub-scanning direction D**2** (see FIG. **13**) concerning the dot corresponding to the present print period G(N).

A print period F for one line of print lines is divided into main pulse adding time MH, sub-pulse adding time SH and off-time OFF.

As shown in FIGS. **17** and **18**, the print pulse added within the main pulse adding time MH is defines as main pulse MP. The dot on the print line to which the main pulse is added is the "color development dot". That is to say, in FIG. **17**, the dot positioned at the coordinate DATA(X, Y) within the print area Z (see FIG. **13**), such dot positioning on the print line corresponding to the present print period G(N), is color-developed. On the other hand, in FIG. **18**, the dot positioned at the coordinate DATA(X, Y+1) within the print area Z (see FIG. **13**), such dot positioning on the print line corresponding to the next print period G(N+1), is color-developed.

As shown in FIG. **17**, in case that the main pulse is added in the present print period G(N) and is not added in the next print period G(N+1), the print pulse added within the sub-pulse adding time SH in the present print period G(N) is defined as supplemental pulse HP. That is to say, the supplemental pulse HP is the print pulse only supplementing color development function by the main pulse MP in the present print period G(N) during which the supplemental pulse HP is added and the supplemental pulse HP itself does not have color developing ability.

As shown in FIG. **18**, in case that the main pulse is not added in the present print period G(N) and is added in the next print period G(N+1), the print pulse added within the sub-pulse adding time SH in the present print period G(N) is defined as preheat pulse YP. That is to say, the preheat pulse YP is the print pulse only supplementing color development function by the main pulse MP in the next print period G(N+1) during which the main pulse MP is added and the preheat pulse YP itself does not have color developing ability.

The sub-pulse means the print pulse added within the sub-pulse adding time SH, and includes the supplemental pulse HP and the preheat pulse YP. Here, the off time OFF is the time that any of the main pulse MP, the supplemental pulse HP and the preheat pulse YP is not added during the print period F for one line of print lines.

Returning to FIG. **4**, a variable number memory **42** stores variable numbers necessary when the CPU **27** executes various programs. Among the variable numbers, there is included a variable number A, a variable number X, a variable number Y, a variable number M, a variable number S, a variable number for "END", a variable number of "divisional number", a variable number of "printing speed", a variable number of "target speed" and a variable number of "present speed".

The work area **43** retains areas necessary when the CPU **27** executes various programs.

The pulse motor **24** rotates the platen roller **22**, thereby the print tape **3**A is fed by the platen roller **22**.

The motor drive circuit **31** drives to rotate the pulse motor **24** and controls rotational speed of the pulse motor **24** by adding motor pulses to the pulse motor **24**.

The thermal head control circuit **32** controls turning on and turning off of the heat elements **23**A (see FIG. **15**) in the thermal head **23** while changing states of turning on and turning off every the line print data for one line unit in the print lines by dividing the print data stored in the print data memory **41** (the main data M_DATA(X, Y), the supplemental data S_DATA(X, Y), the preheat data P_DATA(X, Y) and the sub-data SUB_DATA(X, Y)), after feeding of the print tape **3**A is started by the platen roller **22**.

Here, in the embodiment, 360 heat elements **23**A (see FIG. **15**) in the thermal head **23** can be turned on every two heat areas divided into two areas according to the main scanning direction D**1** perpendicular to the sub-scanning direction D**2** (see FIG. **13**) coinciding with the tape feed direction. This print operation is defined as "divisional printing" hereinafter. However, the print operation is not limited to this, but the heat elements **23**A may be turned on every more than three heat areas.

The CPU **27** controls the motor drive circuit **31** and the thermal head drive circuit **32** in the print device **1** by using tables such as the preset line number table **33** and programs of flowcharts shown in FIG. **9**, based on the image data stored in the print buffer **40** transmitted from the personal computer **26**, thereby makes printing on the print tape **3**A based on the image data.

[Preset Line Number Table]

The preset line number table **33** shown in FIG. **5** is stored in the ROM **28** (see FIG. **4**) as data table. In this data table, number "20" is stored corresponding to "preset line number 1" and number "10" is stored corresponding to "preset line number 2". Here, both the number "20" corresponding to "preset line number 1" and the number "10" corresponding to "preset line number 2" indicate line number of print lines.

[Dot Number Table]

The on-dot number table **35** shown in FIG. **6** is stored in the ROM **28** (see FIG. **4**) as data table. In this data table, the number "180" is stored corresponding to "maximum on-dot number" and the number "360" is stored corresponding to "total dot number of head". Here, the number "180" corresponding to "maximum on-dot number" is a threshold value used in flowcharts shown in FIG. **11**. The number "360" means the total number of 360 heat elements **23**A in the thermal head **23**.

[Table for Speed and Printing]

The table **36** for speed and printing shown in FIG. **7** is stored in the ROM **28** (see FIG. **4**) as data table. In this data table, items of "speed", "print pulse" and "divisional printing" are allotted to each "number" among numbers "0"~"25".

In the item of "speed", feed speed of the print tape **3**A is stored and represented by dimension [mm/s].

In the item of "print pulse", kinds of print pulse added during print period F for one line of print lines (see FIGS. **16** to **18**) are stored. For the items "0"~"24" among items of "number", "main pulse+supplemental pulse" are stored in the item of "print pulse". This means that the main pulse MP (see FIGS. **17** and **18**) and the supplemental pulse HP (see FIG. **17**) exist as the kind of print pulse added during the print period F (see FIGS. **16** to **18**) for one line of print lines until the speed to feed the print tape **3**A (see FIG. **13**) exists within 0~110 [mm/s]. Contrarily, for only the item "25" among items of "number", "main pulse+sub-pulse (supplemental pulse+preheat pulse)" are stored in the item of "print pulse". This means that the main pulse MP (see FIGS. **17** and **18**), the supplemental pulse HP (see FIG. **17**) and the preheat pulse YP (see FIG. **18**) exist as the kind of print pulse added during the print period F (see FIGS. **16** to **18**) for one line of print lines when the speed to feed the print tape **3**A (see FIG. **13**) exceeds 110 [mm/s].

In the item "divisional printing", it is stored whether or not "divisional printing" can be conducted. Concretely, in the item of "divisional printing", among the items "number", "○" indicating that "divisional printing" can be done is stored in "0"~"9". Contrarily, among the items "number", "–" indicating that "divisional printing" cannot be done is stored in "10"~"25". This means that "divisional printing" can be done until the feed speed of the print tape **3**A (see FIG. **13**) reaches 0~30 [mm/s], "divisional printing" cannot be done after the feed speed of the print tape **3**A exceeds 30 [mm/s].

[Acceleration-Deceleration Table]

The acceleration-deceleration table **37** shown in FIG. **8** is stored in the ROM **28** (see FIG. **4**) as data table. This data table is a table utilized when through-up control and through-down control of the pulse motor **24** (see FIG. **4**) is conducted. In the acceleration-deceleration table **37**, "present speed", "target speed" and "print speed" are stored corresponding to the item "number" of "0"~"25" in the table **37** for speed and printing shown in FIG. **7**. Here, "present speed", "target speed" and "print speed" respectively indicate the feed speed to feed the print tape **3**A (see FIG. **13**).

For instance, in the acceleration-deceleration table **37** shown in FIG. **8**, "0" indicates that the feed speed to feed the print tape **3**A is the lowest speed of 0 [mm/s] (see FIG. **7**). "1" indicates that the feed speed to feed the print tape **3**A is 2 [mm/s] (see FIG. **7**). "2" indicates that the feed speed to feed the print tape **3**A is 4 [mm/s] (see FIG. **7**). Similarly, "25" indicates that the feed speed to feed the print tape **3**A is the highest speed of 114 [mm/s] (see FIG. **7**).

Furthermore, it will be described reading method of the acceleration-deceleration table **37** shown in FIG. **8**. For example, it will be conceived a through-up control case that "target speed" to feed the print tape **3**A (see FIG. **13**) is "24" and "present speed" to feed the print tape **3**A is "21".

In the through-up control case, at first, "22" existing at the intersectional point of "24" of "target speed" and "21" of "present speed" is set to "print speed" to feed the print tape **3**A (see FIG. **13**), by using the acceleration-deceleration table **37** shown in FIG. **8**.

Next, "22" of "print speed" is set to "present speed" and "23" existing at the intersectional point of "24" of "target speed" and "22" of "present speed" is set to "print speed" to feed the print tape **3**A (see FIG. **13**) by using the acceleration-deceleration table **37** shown in FIG. **8**.

Continuously, "23" of "print speed" is set to "present speed" and "24" existing at the intersectional point of "24" of "target speed" and "23" of "present speed" is set to "print speed" to feed the print tape **3**A (see FIG. **13**) by using the acceleration-deceleration table **37** shown in FIG. **8**.

Next, "24" of "print speed" is set to "present speed" and "24" existing at the intersectional point of "24" of "target speed" and "24" of "present speed" is set to "print speed" to feed the print tape **3**A (see FIG. **13**) by using the acceleration-deceleration table **37** shown in FIG. **8**. Hereinafter, similar reading method is repeated based on the acceleration-deceleration table **37** of FIG. **8** and both of "print speed" and "present speed" are retained as "24".

Here, on the contrary, it will be conceived the through-down control case that "target speed" to feed the print tape **3**A (see FIG. **13**) is "9" and "present speed" to feed the print tape **3**A is "17".

In the above through-down control case, at first, "15" existing at the intersectional point of "9" of "target speed" and "17" of "present speed" is set to "print speed" to feed the print tape **3**A (see FIG. **13**), by using the acceleration-deceleration table **37** shown in FIG. **8**.

Next, "15" of "print speed" is set to "present speed" and "12" existing at the intersectional point of "9" of "target speed" and "15" of "present speed" is set to "print speed" to feed the print tape **3**A (see FIG. **13**) by using the acceleration-deceleration table **37** shown in FIG. **8**.

Continuously, "12" of "print speed" is set to "present speed" and "9" existing at the intersectional point of "9" of "target speed" and "12" of "present speed" is set to "print speed" to feed the print tape **3**A (see FIG. **13**) by using the acceleration-deceleration table **37** shown in FIG. **8**.

Next, "9" of "print speed" is set to "present speed" and "9" existing at the intersectional point of "9" of "target speed" and "9" of "present speed" is set to "print speed" to feed the print tape **3**A (see FIG. **13**) by using the acceleration-deceleration table **37** shown in FIG. **8**. Hereinafter, similar reading method is repeated based on the acceleration-deceleration table **37** of FIG. **8** and both of "print speed" and "present speed" are retained as "9".

[Control Flowcharts]

The CPU **27** executes the program of flowchart shown in FIG. **9**. First, at step **10** (hereinafter, abbreviated as "S"), the CPU **27** executes initialization process. In this initialization process, for example, "0" is substituted in the variable number of "print speed".

At S**11**, the CPU **27** executes print data formation process. In this print data formation process, the CPU **27** executes the program of flowchart shown in FIG. **10** and forms the supplemental data S_DATA(X, Y), the preheat data P_DATA(X, Y) and the sub-data SUB_DATA(X, Y) by using the main data M_DATA(X, Y). Here, the main data M_DATA(X, Y) coincides with the image data which is the two-dimensional data groups transmitted from the personal computer **26**.

In FIG. **10**, at step S**21**, the CPU **27** substitutes "0" in a range of X=0~359 and Y=0~END to each of two-dimensional data groups of the supplemental data S_DATA(X, Y), the preheat data P_DATA(X, Y) and the sub-data SUB_DATA(X, Y). That is to say, for the supplemental data S_DATA(X, Y), the preheat data P_DATA(X, Y) and the sub-data SUB_DATA (X, Y), the range of print area Z is made "0". Here, as mentioned, END is the variable number indicating Y-direction position of the last print line in the print area z.

At S**22**, the CPU **27** substitutes "0" for the variable numbers X and Y. At S**23**, the CPU **27** determines whether the main data M_DATA(X, Y)=1 is established. Here, if the main data M_DATA(X, Y)=1 is established (S**23**: YES), procedure shifts to S**24**.

At S**24**, the CPU **27** determines whether the variable number Y is smaller than the variable number END. Here, if the variable number Y is not smaller than the variable number END (S**24**: NO), procedure shifts to S**30** mentioned hereinafter. On the contrary, if the variable number Y is smaller than the variable number END (S**24**: YES), procedure shifts to S**25**.

At S**25**, the CPU **27** determines whether the main data M_DATA(X, Y+1)=0. Here, if the main data M_DATA(X, Y+1)=0 is not established (S**25**: NO), procedure shifts to S**30** mentioned hereinafter. Contrarily, if the main data M_DATA (X, Y+1)=0 is established (S**25**: YES), procedure shifts to S**26**.

At S**26**, the CPU **27** sets the supplemental data S_DATA(X, Y)=1. Thereafter, procedure shifts to S**30** mentioned hereinafter.

On the other hand, at the above S**23**, if the main data M_DATA(X, Y)=1 is not established (S**23**: NO), procedure shifts to S**27**.

At S**27**, the CPU **27** determines whether the variable number Y is smaller than the variable number END. Here, if the variable number Y is not smaller than the variable number END (S**27**: NO), procedure shifts to S**30** mentioned hereinafter. On the contrary, if the variable number Y is smaller than the variable number END (S**27**: YES), procedure shifts to S**28**.

At S**28**, the CPU **27** determines whether the main data M_DATA(X, Y+1)=0 is established. Here, if the main data M_DATA(X, Y+1)=0 is established (S**28**: YES), procedure shifts to S**30** mentioned hereinafter. On the contrary, if the main data M_DATA(X, Y+1)=0 is not established (S**28**: NO), procedure shifts to S**29**.

At S**29**, the CPU **27** sets the preheat data P_DATA(X, Y)=1. Thereafter, procedure shifts to S**30**.

At S**30**, the CPU **27** determines whether both the supplemental data S_DATA(X, Y)=0 and the preheat data P_DATA (X, Y)=0 are established. Here, if the supplemental data S_DATA(X, Y)=1 or the preheat data P_DATA(X, Y)=1 is established (S**30**: NO), procedure shifts to S**31**.

At S**31**, the CPU **27** sets the sub-data SUB_DATA(X, Y)=1. Thereafter, procedure shifts to S**32** mentioned hereinafter.

On the other hand, at the above S**30**, if the supplemental data S_DATA(X, Y)=0 and the preheat data P_DATA(X, Y)=0 are established (S**30**: YES), procedure shifts to S**32**.

At S**32**, the CPU **27** adds "1" to the variable number X. Thereafter, procedure shifts to S**33**.

At S**33**, the CPU **27** determines whether the variable number X is "360". Here, if the variable number X is not "360" (S**33**: NO), procedure returns to S**23** and processes after S**23** are repeated. On the contrary, if the variable number X is "360" (S**33**: YES), procedure shifts to S**34**.

At S**34**, the CPU **27** substitutes "0" to the variable number X and "1" to the variable number Y. Thereafter, procedure shifts to S**35**.

At S**35**, the CPU **27** determines whether the number obtained by adding "1" to the variable number END and the variable number Y is equal with each other. Here, if the number obtained by adding "1" to the variable number END is not equal with the variable number Y (S**35**: NO), procedure returns to S**23** and processes after S**23** are repeated. On the contrary, if the number obtained by adding "1" to the variable number END is equal with the variable number Y (S**35**: YES), procedure returns to S**12** in FIG. **9** after the print data formation process indicated in FIG. **10** is done.

As mentioned above, by executing the print data formation process in FIG. **10**, the supplemental data S_DATA(X, Y), the preheat data P_DATA(X, Y) and the sub-data SUB_DATA(X, Y) are formed.

Hereinafter, it will be described with reference to FIG. **14** the supplemental data S_DATA(X, Y), the preheat data P_DATA(X, Y) and the sub-data SUB_DATA(X, Y), formed according to the above.

In FIG. **14**, each one line of plural print lines arranged in the direction parallel with the main scanning direction D**1** and along with the sub-scanning direction D**2** is structured from the main line ML to which the main pulse MP (see FIGS. **17** and **18**) is added and the sub-line SL to which one of the supplemental pulse HP (see FIG. **17**) and the preheat pulse YP (see FIG. **18**) is added.

The main line ML and the sub-line SL forming each one line of print lines is sectioned totally in 360 sections, 360 representing the total number of heat elements **23**A (see FIG. **15**) on the thermal head **23**. In each one line of print lines, one section of the main line ML and one section of the sub-line SL, the main line ML and the sub-line SL being arranged with an adjacent relation in the sub-scanning direction D**2**, forms one dot.

At the right side (downstream side in the tape feed direction) of the sub-scanning direction D**2**, one print line adjacent to the present print one line is the next one print line. Contrarily, at the left side of the sub-scanning direction, one print line adjacent to the present print one line is the previous print one line.

Hereafter, it will be described the supplemental data S_DATA(X, Y) formed on the basis of the main data M_DATA(X, Y) by executing the print data formation process shown in FIG. **10**.

Here, when the main pulse MP (see FIGS. **17** and **18**) is added to one dot of the present print one line (S**23**: YES) and is not added to one dot of the next print one line adjacent to the right side (downstream side in the tape feed direction) of the one dot in the sub-scanning direction D**2** (S**25**: YES), it is supposed that the supplemental pulse HP (see FIG. **17**) is added to the one dot of the present print one line. That is to say, "1" is substituted to the supplemental data S_DATA(X, Y) corresponding to the one dot of present print one line (S**26**).

On the contrary, when the main pulse MP (see FIGS. **17** and **18**) is added to one dot of the present print one line (S**23**: YES) and one dot of the next print one line adjacent to the right side (downstream side in the tape feed direction) of the one dot in the sub-scanning direction D**2** (S**25**: YES) does not exist (S**24**: NO), it is supposed that the supplemental pulse HP (see FIG. **17**) is not added to the one dot of the present print one line. That is to say, it is continued a state that "0" is substituted to the supplemental data S_DATA(X, Y) corresponding to the one dot of present print one line (S**21**).

Further, when the main pulse MP (see FIGS. **17** and **18**) is added to one dot of the present print one line (S**23**: YES) and is also added to one dot of the next print one line adjacent to the right side (downstream side in the tape feed direction) of the one dot in the sub-scanning direction D**2** (S**25**: NO), it is supposed that the supplemental pulse HP (see FIG. **17**) is not added to the one dot of the present print one line. That is to say, it is continued a state that "0" is substituted to the supplemental data S_DATA(X, Y) corresponding to the one dot of present print one line (S**21**).

Furthermore, when the main pulse MP (see FIGS. **17** and **18**) is not added to one dot of the present print one line (S**23**: NO) and is not added to one dot of the next print one line adjacent to the right side (downstream side in the tape feed direction) of the one dot in the sub-scanning direction D**2** (S**28**: YES), it is supposed that the supplemental pulse HP (see FIG. **17**) is not added to the one dot of the present print one line. That is to say, it is continued a state that "0" is substituted to the supplemental data S_DATA(X, Y) corresponding to the one dot of present print one line (S**21**).

Hereafter, it will be described the preheat data P_DATA(X, Y) formed on the basis of the main data M_DATA(X, Y) by executing the print data formation process shown in FIG. **10**.

Here, when the main pulse MP (see FIGS. **17** and **18**) is not added to one dot of the present print one line (S**23**: NO) and is added to one dot of the next print one line adjacent to the right side (downstream side in the tape feed direction) of the one dot in the sub-scanning direction D**2** (S**28**: NO), it is supposed that the preheat pulse YP (see FIG. **18**) is added to the one dot of the present print one line. That is to say, "1" is substituted to the preheat data P_DATA(X, Y) corresponding to the one dot of present print one line (S**29**).

Further, when the main pulse MP (see FIGS. **17** and **18**) is added to one dot of the present print one line (S**23**: YES) and is also added to one dot of the next print one line adjacent to the right side (downstream side in the tape feed direction) of the one dot in the sub-scanning direction D**2** (S**25**: NO), it is supposed that the preheat pulse YP (see FIG. **18**) is not added to the one dot of the present print one line. That is to say, it is continued a state that "0" is substituted to the preheat data P_DATA(X, Y) corresponding to the one dot of present print one line (S**21**).

Furthermore, when the main pulse MP (see FIGS. **17** and **18**) is not added to one dot of the present print one line (S**23**: NO) and one dot of the next print one line adjacent to the right side (downstream side in the tape feed direction) of the one dot in the sub-scanning direction D**2** does not exist (S**27**: NO), it is supposed that the preheat pulse YP (see FIG. **18**) is not added to the one dot of the present print one line. That is to say, it is continued a state that "0" is substituted to the preheat data P_DATA(X, Y) corresponding to the one dot of present print one line (S**21**).

Furthermore, when the main pulse MP (see FIGS. **17** and **18**) is not added to one dot of the present print one line (S**23**: NO) and is not added to one dot of the next print one line adjacent to the right side (downstream side in the tape feed direction) of the one dot in the sub-scanning direction D**2** (S**28**: YES), it is supposed that the preheat pulse YP (see FIG. **18**) is not added to the one dot of the present print one line. That is to say, it is continued a state that "0" is substituted to the preheat data P_DATA(X, Y) corresponding to the one dot of present print one line (S**21**).

Hereafter, it will be described the sub-data SUB_DATA(X, Y) formed by executing the print data formation process shown in FIG. **10**.

The sub-data SUB_DATA(X, Y) is the logical sum of the supplemental data S_DATA(X, Y) and the preheat data P_DATA(X, Y) (S**21**, S**30**, S**31**). That is to say, the sub-data SUB_DATA(X, Y)=1 means that one of the supplemental pulse HP (see FIG. **17**) and the preheat pulse YP (see FIG. **18**) is added to one dot of one print line corresponding to the sub-data SUB_DATA(X, Y). On the contrary, the sub-data SUB_DATA(X, Y)=0 means that any of the supplemental pulse HP (see FIG. **17**) and the preheat pulse YP (see FIG. **18**) is not added to one dot of one print line corresponding to the sub-data SUB_DATA(X, Y).

As mentioned above, after the print data formation process in FIG. **10** is done, procedure returns to FIG. **9** and the CPU **27** executes the maximum on-dot number determination process at S**12**. In the maximum on-dot number determination process, the CPU **27** refers the dot number table **35** shown in FIG. **6** and the number "180" corresponding to the "maximum on-dot number" is substituted to the variable number A. Here, the number "180" means a half number of total 360 heat elements **23**A on the thermal head **23**.

At S**13**, the CPU **27** executes the target speed judgment process. This target speed judgment process is done by executing the program of flowchart shown in FIG. **11** through the CPU **27**.

In FIG. **11**, at S**41**, the CPU **27** determines whether the variable number M is larger than the variable number A. Here, the variable number M is obtained as follows. That is to say, every 20 print lines lined up to the number "20" corresponding to the "preset line number 1" at the right side (downstream side in tape feed direction) from the present print line in the sub-scanning direction D**2**, it is counted a dot number that the main pulse MP (see FIGS. **17** and **18**) is added. Further, the most count number is substituted to the variable number M. Here, this counting is done based on the main data M_DATA (X, Y). And the number "20" corresponding to the "preset line number 1" is read out from the preset line number table **33** shown in FIG. **5**. The variable number A is "180" as mentioned above.

Here, when the variable number M is larger than the variable number A (S**41**: YES), procedure shifts to S**42**. At S**42**, the CPU **27** sets a value of variable number M/variable number A to the variable number of "divisional number". Here, although the value of variable number M/variable number A is calculated by bringing forward decimal, such value becomes "2" in the embodiment. At **S43**, the CPU **27** sets "9" to the variable number of "target speed". Thereafter, procedure shifts to S**13** in FIG. **9**.

On the contrary, at **S41**, when the variable number M is not larger than the variable number A (**S41**: NO), procedure shifts to S**44**. At S**44**, the CPU **27** determines whether the variable number S is larger than the variable number A. Here, the variable number S is obtained as follows. That is to say, every 20 print lines lined up to the number "20" corresponding to the "preset line number 1" at the right side (downstream side in tape feed direction) from the present print line in the sub-scanning direction D**2**, it is counted a dot number that the supplemental pulse HP (see FIG. **17**) is added. Further, the most count number is substituted to the variable number S. Here, this counting is done based on the supplemental data S_DATA(X, Y). And the number "20" corresponding to the "preset line number 1" is read out from the preset line number table **33** shown in FIG. **5**. The variable number A is "180" as mentioned above.

Here, when the variable number S is larger than the variable number A (**S44**: YES), procedure shifts to **S45**. At **S45**, the CPU **27** sets "0" to the variable number of "divisional number". At S**46**, the CPU **27** sets "24" to the variable number of "target speed". Thereafter, procedure shifts to S**13** in FIG. **9**.

On the contrary, when the variable number S is not larger than the variable number A (**S44**: NO), procedure shifts to **S47**. At **S47**, the CPU **27** sets "0" to the variable number of "divisional number". At **S48**, the CPU **27** sets "25" to the variable number of "target speed". Thereafter, procedure shifts to S**13**.

As described above, after the target speed judgment process shown in FIG. **11** is done, procedure returns to FIG. **9**. The CPU **27** executes the print speed selection process at S**14**. In the print speed selection process, the variable number of "print speed" is obtained by using the acceleration-deceleration table **37** shown in FIG. **8**. Thereafter, procedure shifts to S**15**.

For example, in case that "9" is set to the variable number of "target speed" and "1" is set to the variable number of "present speed", "9" existing at the intersectional point of "9" of "target speed" and "1" of "present speed" is obtained as the variable number of "print speed" by using the acceleration-deceleration table **37** shown in FIG. **8**.

On the contrary, when "9" is set to the variable number of "target speed" and "15" is set to the variable number of "present speed", "12" existing at the intersectional point of "9" of "target speed" and "15" of "present speed" is obtained as the variable number of "print speed" by using the acceleration-deceleration table **37** shown in FIG. **8**.

When "24" is set to the variable number of "target speed" and "1" is set to the variable number of "present speed", "10" existing at the intersectional point of "24" of "target speed" and "1" of "present speed" is obtained as the variable number of "print speed" by using the acceleration-deceleration table **37** shown in FIG. **8**.

On the contrary, when "24" is set to the variable number of "target speed" and "25" is set to the variable number of "present speed", "24" existing at the intersectional point of "24" of "target speed" and "25" of "present speed" is obtained as the variable number of "print speed" by using the acceleration-deceleration table **37** shown in FIG. **8**.

Further, when "25" is set to the variable number of "target speed" and "1" is set to the variable number of "present speed", "10" existing at the intersectional point "25" of "target speed" and "1" of "present speed" is obtained as the variable number of "print speed" by using the acceleration-deceleration table **37** shown in FIG. **8**.

On the contrary, when "25" is set to the variable number of "target speed" and "25" is set to the variable number of "present speed", "25" existing at the intersectional point of "25" of "target speed" and "25" of "present speed" is obtained as the variable number of "print speed" by using the acceleration-deceleration table **37** shown in FIG. **8**.

Returning to FIG. **9**, at **S15**, the CPU **27** executes one line print process. This one line print process is done by executing the program of flowchart shown in FIG. **12** through the CPU **27**.

In FIG. **12**, at S**51**, the CPU **27** executes the motor pulse **1** input process. In the motor pulse **1** input process, the CPU **27** inputs motor pulse **1** to the pulse motor **24** so that the feed speed feeding the print tape **3**A (see FIG. **13**) becomes a speed corresponding to the "number" which is the variable number of "print speed" (see FIGS. **19** and **20** described hereinafter).

At **S52**, the CPU **27** determines whether the variable number of "divisional number" is larger than "0". If the variable number of "divisional number" is not larger than "0" (**S52**: NO), procedure shifts to **S53**. At **S53**, the CPU **27** determines whether the variable number of "print speed" is "25". If the variable number of "print speed" is not "25" (**S53**: NO), procedure shifts to **S54**.

At **S54**, the CPU **27** executes transmission process of the main data M_DATA(X, Y). Concretely, the main data M_DATA(X, Y) for one line of the present print lines is transmitted to the thermal head control circuit **32**.

At **S55**, the CPU **27** executes main pulse print process. Concretely, the thermal head control circuit **32** adds the main pulse MP (see FIGS. **17** and **18**) to the heat elements **23**A of thermal head **23** based on the main data M_DATA(X, Y) for one line of the present print lines. Thereafter, the CPU **27** inputs motor pulse **2** to the pulse motor **24** so that the feed speed feeding the print tape **3**A (see FIG. **13**) becomes a speed corresponding to the "number" which is the variable number of "print speed" (see FIG. **19** described hereinafter).

At **S56**, the CPU **27** executes supplemental data transmission process. Concretely, the supplemental data S_DATA(X, Y) for one line of the present print lines is transmitted to the thermal head control circuit **32**.

At **S57**, the CPU **27** executes supplemental pulse print process. Concretely, the thermal head control circuit **32** adds the supplemental pulse HP (see FIG. **17**) to the heat elements **23**A of thermal head **23** based on the supplemental data S_DATA(X, Y) for one line of the present print lines. That is, in this process, the preheat pulse YP (see FIG. **18**) is not added to the heat elements **23**A. Thereafter, procedure shifts to **S68** described hereinafter.

On the other hand, at the above **S53**, if the variable number of "print speed" is "25" (**S53**: YES), procedure shifts to **S58**.

At **S58**, the CPU **27** executes transmission process of the main data M_DATA(X, Y). Concretely, the main data M_DATA(X, Y) for one line of the present print lines is transmitted to the thermal head control circuit **32**.

At **S59**, the CPU **27** executes main pulse print process. Concretely, the thermal control circuit **32** adds the main pulse MP (see FIGS. **17** and **18**) to the head elements **23**A of thermal head **23** based on the main data M_DATA(X, Y) for one line of the present print lines. Thereafter, the CPU **27** inputs motor pulse **2** to the pulse motor **24** so that the feed speed feeding the print tape **3**A (see FIG. **13**) becomes a speed corresponding to the "number" which is the variable number of "print speed" (see FIG. **19** described hereinafter).

At **S60**, the CPU **27** executes transmission process of the sub-data SUB_DATA(X, Y). Concretely, the sub-data SUB_

DATA(X, Y) for one line of the present print lines is transmitted to the thermal head control circuit **32**.

At S**61**, the CPU **27** executes sub-pulse print process. Concretely, the thermal head control circuit **32** adds the supplemental pulse HP (see FIG. **17**) or the preheat pulse YP (see FIG. **18**) to the heat elements **23**A of thermal head **23** based on the sub-data SUB_DATA(X, Y) for one line of the present print lines. That is, in this process, the supplemental pulse HP (see FIG. **17**) or the preheat pulse YP (see FIG. **18**) is added. Thereafter, procedure shifts to S**68**.

On the other hand, if the variable number of "divisional number" is larger than "0" (S**52**: YES), procedure shifts to S**62**. At S**62**, the CPU **27** executes transmission process of the divisional main data M_DATA(X, Y). Concretely, the main data M_DATA(X, Y) corresponding to the main data M_DATA(X, Y) obtained by dividing the main data M_DATA (X, Y) for one line of the present print lines by the variable number of "divisional number", is added to the thermal head control circuit **32**.

At S**63**, the CPU **27** executes main pulse print process. Concretely, the thermal head control circuit **32** adds the main pulse MP (see FIGS. **17** and **18**) to the head elements **23**A of thermal head **23** based on the main data M_DATA(X, Y) obtained by dividing the main data M_DATA(X, Y) for one line of the present print lines by the variable number of "divisional number".

At S**64**, the CPU **27** executes transmission process of divisional supplemental data S_DATA(X, Y). Concretely, the supplemental data S_DATA(X, Y) corresponding to the supplemental data S_DATA(X, Y) obtained by dividing the supplemental data S_DATA(X, Y) for one line of the present print lines by the variable number of "divisional number", is transmitted to the thermal head control circuit **32**.

At S**65**, the CPU **27** executes supplemental pulse print process. Concretely, the thermal head control circuit **32** adds the supplemental pulse HP (see FIG. **17**) to the heat elements **23**A of thermal head **23** based on the supplemental data S_DATA(X, Y) obtained by dividing the supplemental data S_DATA(X, Y) for one line of the present print lines by the variable number of "divisional number". That is, in this process, the preheat pulse YP (see FIG. **18**) is not added.

At S**66**, the CPU **27** subtracts "1" from the variable number of "divisional number". At S**67**, the CPU **27** determines whether the variable number of "divisional number" is larger than "0". If the variable number of "divisional number" is larger than "0" (S**67**: YES), procedure returns to S**62** and processes after S**62** are repeated. Here, before and after process of S**62** is repeated, the CPU **27** inputs motor pulse **2** to the pulse motor **24** so that the feed speed feeding the print tape **3**A (see FIG. **13**) becomes a speed corresponding to the "number" which is the variable number of "print speed" (see FIG. **20** hereinafter described).

On the contrary, if the variable number of "divisional number" is not larger than "0" (S**67**: NO), the CPU **27** returns the variable number of "divisional number" to "0" or "2" set in the target speed judgment process in S**13**. Thereafter, procedure shifts to S**68**.

At S**68**, the CPU **27** substitutes the "number" corresponding to the variable number of "print speed" to the variable number of "present speed". Thereafter, procedure shifts to S**16** in FIG. **9**.

Hereinafter, so that the feed speed feeding the print tape **3**A (see FIG. **13**) becomes the speed corresponding to the "number" which is the variable number of "print speed", timing to input motor pulse **1** and motor pulse **2** to the pulse motor **24** and timing of data transmission will be described with reference to FIGS. **19** and **20**.

In case that one line printing is done according to S**51** to S**57** in FIG. **12**, motor pulse input and data transmission are conducted at the timing shown in FIG. **19**. That is to say, when the main pulse adding time MH in the present print period G(N) is started, the motor pulse **1** is input to the pulse motor **24** (S**51**) and the main data M_DATA(X, Y) is continuously transmitted (S**54**). And right before the sub-pulse adding time SH in the present print period G(N) is started, the motor pulse **2** is input to the pulse motor **24**. Further, when the sub-pulse adding time SH in the present print period G(N) is started, the supplemental data S_DATA(X, Y) is transmitted (S**56**).

In case that one line printing is conducted according to S**51**~S**53**, S**58**~S**61**, motor pulse input or data transmission is done at the timing indicated in FIG. **19**. That is to say, when the main pulse adding time MH in the present print period G(N) is started, the motor pulse **1** is input to the pulse motor **24** (S**51**), and the main data M_DATA(X, Y) is continuously transmitted (S**58**). And right before the sub-pulse adding time SH in the present print period G(N) is started, the motor pulse **2** is input to the pulse motor **24**, and when the sub-pulse adding time SH in the present print period G(N) is started, the sub-data SUB_DATA(X, Y) is transmitted (S**60**).

In case that one line printing is conducted according to S**51**, S**52**, S**62**~S**67**, this case corresponds to a case that "divisional printing" where the variable number of "divisional number" is 2 is conducted in the embodiment, and motor pulse input process or data transmission is done at the timing shown in FIG. **20**. That is to say, when the first main pulse adding time MH in the present print period G(N) is started, the motor pulse **1** is input to the pulse motor **24** (S**51**) and the first divisional main data M_DATA(X, Y) is continuously transmitted (S**62**). When the first sub-pulse adding time SH in the present print period G(N) is started, the first divisional supplemental data S_DATA(X, Y) is transmitted (S**64**). Further, right before or after the last main pulse adding time MH in the present print period G(N) is started, the motor pulse **2** is input to the pulse motor **24**. When the last main pulse adding time MH in the present print period G(N) is started, the last divisional main data M_DATA(X, Y) is transmitted (S**62**). Thereafter, when the last sub-pulse adding time SH in the present print period G(N) is started, the last divisional supplemental data S_DATA(X, Y) is transmitted (S**64**).

Returning to FIG. **9**, at S**16**, the CPU **27** determines whether one line printing up to the number "10" corresponding to "preset line number 2" is conduced. Here, the number "10" corresponding to "preset line number 2" is read out from the preset line number table **33** shown in FIG. **5**. When it is determined that one line printing up to the number "10" corresponding to "preset line number 2" is not conducted (S**16**: NO), procedure returns to S**14** and processes of S**14** to S**16** are repeated.

At that time, when the variable number of "target speed" is set to the number "9" (S**43** in FIG. **11**), divisional printing by the main pulse MP (see FIGS. **17** and **18**) and the supplemental pulse HP (see FIG. **17**) is done (S**51**, S**52**, S**62**~S**67** in FIG. **12**) by using the acceleration-deceleration table **37** shown in FIG. **8** and the table **36** indicating relation between speed and printing shown in FIG. **7**. During divisional printing, the pulse motor **24** is controlled so that the feed speed feeding the print tape **3**A (see FIG. **13**) becomes 30 [mm/s] corresponding to the number "9" which is the variable number of "target speed".

Further, when the variable number of "target speed" is set to "24" (S**46** in FIG. **11**), printing by the main pulse MP (see FIGS. **17** and **18**) and the supplemental pulse HP (see FIG. **17**) is conducted (S**51**~S**57** in FIG. **12**) by using the acceleration-deceleration table **37** shown in FIG. **8** and the table **36** indicating relation between speed and printing shown in FIG. **7**, because the variable number of "print speed" is the number lower than "25" (S**53**: NO in FIG. **12**). During such printing, the pulse motor **24** is controlled so that the feed speed feeding the print tape **3**A (see FIG. **13**) becomes 110 [mm/s] corresponding to the number "24" which is the variable number of "target speed".

Furthermore, when the variable number of "target speed" is set to "25" (S**48** in FIG. **11**), printing by the main pulse MP (see FIGS. **17** and **18**), the supplemental pulse HP (see FIG. **17**) and the preheat pulse YP (see FIG. **18**) is conducted (S**51**~S**53**, S**58**~S**61** in FIG. **12**) by using the acceleration-deceleration table **37** shown in FIG. **8** and the table **36** indicating relation between speed and printing shown in FIG. **7**, because the variable number of "print speed" is the number "25" (S**53**: YES in FIG. **12**). During such printing, the pulse motor **24** is controlled so that the feed speed feeding the print tape **3**A (See FIG. **13**) becomes 114 [mm/s] corresponding to the number "25" which is the variable number of "target speed".

On the other hand, at S**16**, when one line printing up to "10" corresponding to "preset line number 2" is conducted (S**16**: YES), procedure shifts to S**17**. At S**17**, the CPU **27** determines whether one line printing is conducted for all print lines. If the one line printing is not conducted for all print lines (S**17**: NO), procedure returns to S**12** and processes of S**12** to S**17** are repeated. Contrarily, if one line printing for all print lines is conducted (S**17**: YES), procedure shifts to S**18**.

At S**18**, the CPU **27** executes motor stop process. In the motor stop process, the pulse motor **24** is stopped. Thereafter, program shown in FIG. **9** is done.

SUMMARY

(1) In the printing device **1** according to the embodiment, every 20 print lines lined up to the number "20" corresponding to the "preset line number 1" at the right side (downstream side in tape feed direction) from the present print line in the sub-scanning direction D**2**, it is counted a dot number that the main pulse MP (see FIGS. **17** and **18**) is added. Further, when the variable number M which is the most count number is larger than the variable number A (S**41**: YES), the value obtained from variable number M/variable number A is set to the variable number of "divisional number" (S**42**) and "9" is set to the variable number of "target speed" (S**43**). One line printing by "divisional printing" in S**51**, S**52**, S**62**~S**67** in FIG. **12** (corresponding to "divisional process") is done up to the number "10" corresponding to "preset line number 2". At that time, the main pulse MP (see FIGS. **17** and **18**) is added to the heat elements **23**A of thermal head **23** (S**63**) and the supplemental pulse HP (see FIG. **17**) is added to the heat elements **23**A of thermal head **23** (S**65**).

(2) Further, when the variable number M which is the most count number is not larger than the variable number A (S**41**: NO), every 20 print lines lined up to the number "20" corresponding to the "preset line number 1" at the right side (downstream side in tape feed direction) from the present print line in the sub-scanning direction D**2**, it is counted a dot number that the supplemental pulse HP (see FIG. **17**) is added. Further, when the variable number S which is the most count number is larger than the variable number A (S**44**: YES), the value "0" is set to the variable number of "divisional number" (S**45**) and "24" is set to the variable number of "target speed" (S**46**). One line printing in S**51**~S**57** in FIG. **12** (corresponding to "batch process") is done up to the number "10" corresponding to "preset line number 2". At that time, the main pulse MP (see FIGS. **17** and **18**) is added to the heat elements **23**A of thermal head **23** (S**55**) and the supplemental pulse HP (see FIG. **17**) is added to the heat elements **23**A of thermal head **23** (S**57**).

(3) Furthermore, when the variable number S which is the most count number is not larger than the variable number A (S**44**: NO), the value "0" is set the variable number of "divisional number" (S**47**) and "25" is set to the variable number of "target speed" (S**48**). When "print speed" is not "25" (S**53**: NO), one line printing in S**54**~S**57** in FIG. **12** is conducted up to "10" corresponding to "preset line number 2". At that time, the main pulse MP (see FIGS. **17** and **18**) is added to the heat elements **23**A of thermal head **23** (S**55**) and the supplemental pulse HP (see FIG. **17**) is added to the heat elements **23**A of thermal head **23** (S**57**). On the contrary, "print speed" is "25" (S**53**: YES), one line printing in S**58**~S**61** in FIG. **12** (corresponding to "batch process") is conducted up to "10" corresponding to "preset line number 2". At that time, the main pulse MP (see FIGS. **17** and **18**) is added to the heat elements **23**A of thermal head **23** (S**59**) and the supplemental pulse HP (see FIG. **17**) or the preheat pulse YP (see FIG. **18**) is added to the heat elements **23**A of thermal head **23** (S**61**).

In the case above mentioned (1), one line printing of "divisional printing", which is conducted by adding the main pulse MP (see FIGS. **17** and **18**) and the supplemental pulse HP (see FIG. **17**), occurs in a state that "target speed" to feed print tape **3**A (see FIG. **13**) is set to "9" corresponding comparatively low speed.

In the case above mentioned (2), one line printing of "divisional printing", which is conducted by adding the main pulse MP (see FIGS. **17** and **18**) and the supplemental pulse HP (see FIG. **17**), occurs in a state that "target speed" to feed print tape **3**A (see FIG. **13**) is set to "24" corresponding comparatively high speed.

In the case above mentioned (3), similar to the case (2), one line printing of "divisional printing", which is conducted by adding the main pulse MP (see FIGS. **17** and **18**) and the supplemental pulse HP (see FIG. **17**), occurs in s state that "target speed" to feed print tape **3**A (see FIG. **13**) is set to "24" corresponding comparatively high speed. In addition, one line printing of "divisional printing", which is conducted by adding the main pulse MP (see FIGS. **17** and **18**), the supplemental pulse HP (see FIG. **17**) and the preheat pulse YP (see FIG. **18**), occurs in s state that "target speed" to feed print tape **3**A (see FIG. **13**) is set to "25" of the highest speed exceeding "24" corresponding comparatively high speed.

[Others]

As described above, the printing device **1** according to the embodiment, "divisional printing" occurs and printing with high speed can be conducted even if the supplemental pulse HP (see FIG. **17**) and the preheat pulse YP (see FIG. **18**) are utilized in printing.

Here, the present disclosure is not limited to the above embodiment and various changes can be done within the scope of the disclosure.

For example, instead of controlling done according to FIGS. **7**, **8**, **11** and **12**, controlling according to new FIGS. **21**, **22**, **23** and **24** can be done. Hereafter, differences occurring by changing figures will be described.

In the table for speed and printing of FIG. **7**, "main pulse+supplemental pulse" is stored for the "number" item of "18" to "24" in the item of "print pulse". On the other hand, in the table for speed and printing of FIG. **21**, "main pulse+sub-pulse (supplemental pulse+preheat pulse)" is stored for the "number" item of "18" to "24" in the item of "print pulse".

In the acceleration-deceleration table shown in FIG. **8**, "16" is respectively stored at the intersectional point of "17"~"25" of "target speed" and "14" of "present speed", "18" is respectively stored at the intersectional point of "19"~"25" of "target speed" and "17" of "present speed", "19" is respectively stored at the intersectional point of "20"~"25" of "target speed" and "18" of "present speed", "20" is respectively stored at the intersectional point of "21"~"25" of "target speed" and "19" of "present speed" and "21" is respectively stored at the intersectional point of "22"~"25" of "target speed and "20" of "present speed".

On the other hand, in the acceleration-deceleration table shown in FIG. **22**, "17" is respectively stored at the intersectional point of "17"~"25" of "target speed" and "14" of "present speed", "19" is respectively stored at the intersectional point of "19"~"25" of "target speed" and "17" of "present speed", "20" is respectively stored at the intersectional point of "20"~"25" and "18" of "present speed", "21" is respectively stored at the intersectional point of "21"~"25" of "target speed" and "19" of "present speed" and "22" is respectively stored at the intersectional point of "22"~"25" of "target speed" and "20" of "present speed".

That is, in comparison with the acceleration-deceleration table in FIG. **8**, at the intersectional point of "17"~"25" of "target speed" and "14" of "present speed", at the intersectional point of "19"~"25" of "target speed" and "17" of "present speed", at the intersectional point of "20"~"25" of "target speed" and "18" of "present speed", at the intersectional point of "21"~"25" of "target speed" and "19" of "present speed" and at the intersectional point of "22"~"25" of "target speed" and "20" of "present speed", the value increased by "1" is stored in the acceleration-deceleration table in FIG. **22**.

Thereby, in comparison with a case that the acceleration-deceleration table in FIG. **8** is used for control of the pulse motor **24**, when the acceleration-deceleration table in FIG. **22** is used for control of the pulse motor **24**, acceleration-deceleration time in the through-up control and through-down control of the pulse motor **24** can be reduced.

In the target speed judgment process shown in FIG. **23**, comparing with the target speed judgment process shown in FIG. **11**, process of S**101** in which "0" is substituted to the variable number of "preheat" after S**43** is executed, process S**102** in which "0" is substituted to the variable number of "preheat" after S**46** is executed and process **103** in which "1" is substituted to the variable number of "preheat" after S**48** is executed, are added.

In one line print process shown in FIG. **12**, it is determined whether the variable number of "present speed" is "25" in determination process of S**53**. On the contrary, in one line print process shown in FIG. **24**, determination process of S**104** is executed instead of determination process in S**53**. In determination process of S**104**, it is determined whether the variable number of "preheat" is "1".

That is to say, in case that FIGS. **21**, **22**, **23** and **24** are used instead of FIGS. **7**, **8**, **11** and **12**, when the variable number of "preheat" is "1" (S**104**: YES) and the variable number of "print speed" is "18"~"25", one line printing by S**58**~S**61** of FIG. **24** is conducted up to "10" corresponding to "preset line number 2". At that time, the main pulse MP (see FIGS. **17** and **18**) is added to the heat elements **23**A of thermal head **23** (S**59**) and the supplemental pulse HP (see FIG. **17**) or preheat pulse YP (see FIG. **18**) is added to the heat elements **23**A of thermal head **23** (S**61**).

Namely before the variable number of "print speed" becomes "25" corresponding to the highest speed exceeding "24" corresponding to comparatively high speed, one line printing by addition of the main pulse MP (see FIGS. **17** and **18**), the supplemental pulse HP (see FIG. **17**) and the preheat pulse (see FIG. **18**) is done up to the number of "10" corresponding "preset line number 2".

While presently exemplary embodiment have been shown and described, it is to be understood that this disclosure is for the purpose of illustration and that various changes and modifications may be made without departing from the scope of the disclosure as set forth in the appended claims.

What is claimed is:

1. A printing device comprising:

a thermal head provided with a line head in which a plurality of heat elements are linearly lined up;

a feeding device for feeding a thermal print medium in a sub-scanning direction normal to the line head of the thermal head; and

a control device for controlling the feeding device and the thermal head,

wherein the control device conducts a batch process or divisional process of pulse addition to selectively heat the heat elements in the line head of the thermal head in a main scanning direction parallel with the line head every print period continuously and repeatedly, wherein print dots are thereby printed on the thermal print medium fed in the sub-scanning direction by the feeding device in accordance with a feed speed corresponding to the batch process or a feed speed corresponding to the divisional process,

wherein a main pulse adding time of applying a main pulse to color-develop the thermal print medium and a sub-pulse adding time of applying a sub-pulse to supplement the main pulse are retained in each of the print periods,

wherein the sub-pulse is a supplemental pulse for color-developing the thermal print medium by supplementing the main pulse added in a present print period, the supplemental pulse not being able to independently color-develop the thermal print medium or, a preheat pulse to color-develop the thermal print medium by supplementing the main pulse added in a next print period, the preheat pulse not being able to independently color-develop the thermal print medium,

wherein the control device counts a total number of the main pulse every print period within a first predetermined range, and when a maximum value of the total number of the main pulse exceeds a first threshold value, the divisional process is conducted by adding the main pulse and the supplemental pulse every print period within a second predetermined range smaller than the first predetermined range in accordance with the feed speed corresponding to the divisional process,

wherein, when the maximum value of the total number of the main pulse does not exceed the first threshold value, the control device counts a total number of the supplemental pulse every print period within the first predetermined range, and, when a maximum value of the total value of the supplemental pulse exceeds a second threshold value, the batch process is conducted by adding the main pulse and the supplemental pulse every print period within the second predetermined range in accordance with the feed speed corresponding to the batch process, and

wherein, when the total value of the supplemental pulse does not exceed the second threshold value, the batch process is conducted by adding the main pulse and the supplemental pulse every print period within the second predetermined range at the feed speed corresponding to the batch process and the batch process is conducted by adding the main pulse, the supplemental pulse and the preheat pulse every print period within the second predetermined range until the feed speed shifts to a maximum speed by exceeding the feed speed corresponding to the batch process.

2. The printing device according to claim **1**, further comprising:

a pulse motor to drive the feeding device,

wherein the control device controls the feeding device so as to shift to and retain the feed speed corresponding to the divisional process, the feed speed corresponding to the batch process or the maximum speed by conducting a through-up control or a through-down control of the pulse motor.

3. The printing device according to claim **2**, wherein the control device conducts the batch process every print period within the second predetermined range by adding the main pulse, the supplemental pulse and the preheat pulse before the feed speed exceeds the feed speed corresponding to the batch process and shifts to the maximum speed.

4. The printing device according to claim **3**, further comprising:

memory storing:

a first acceleration-deceleration table utilized when the batch process is done every print period within the second predetermined range by adding the main pulse, the supplemental pulse and the preheat pulse before the feed speed exceeds the feed speed corresponding to the batch process and shifts to the maximum speed; and

a second acceleration-deceleration table utilized when the batch process is done every print period within the second predetermined range by adding the main pulse, the supplemental pulse and the preheat pulse while the feed speed exceeds the feed speed corresponding the batch process and shifts to the maximum speed,

wherein the control device selectively uses the first acceleration-deceleration table and the second acceleration-deceleration table, to thereby reduce a number of times of accelerating the feed speed in the through-up control or the through-down control of the pulse motor by using the first acceleration-deceleration table in comparison with a case that the second acceleration-deceleration table is used.

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